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WARREN EDWARDS, 2d V.-P. & Assoc. Ed.

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CONTENTS.



## Organization of Track Gangs.

In doing any kind of track work with common laborers, the organization or distribution of the men is a matter requiring careful consideration and close attention, for it is the proper disposal of men which more than any other one thing affects the amount and quality of work done. It has been said with truth that a gang of poor workers well organized is a better gang and will accomplish more than good workers poorly organized. Time and confusion are saved by assigning each man his task, and requiring him to remain as he is placed until otherwise ordered.

The proper disposal of men implies in general that each one is placed on the kind of work for which he is best fitted, and in which he has had experience. However, this does not mean, for instance, that more men than necessary should be used for bolting or too few for spiking. If there are too many bolters and too few spikers, a foreman will show his ability by picking out of the surplus bolters the men who can be quickly trained to become good spikers. Men of great strength are not necessarily required, for an experienced man of less than ordinary strength who is intelligent and active can accomplish more than a much stronger man, if the latter is less expert or is awkward.

After the gang is rightly organized the amount of work accomplished will depend on the amount of work accomplished by the individual men, or by the different groups of men. The foreman should attempt to get a good day's work out of each one; he should carefully watch and study the class of labor as to general characteristics and traits; and he should also become familiar with the individual traits of each man as far as possible. Some men will do the most work when treated with familiarity, while others will not respect a foreman who takes this attitude.

The amount of work accomplished by the individual is very closely related to gang organization. The best men should be put in the lead, and wherever possible the work should be arranged so that each man will have to do an equal share with the head man, or else fall behind and be easily detected. It is characteristic of the laborer experienced in track work, that he is loth to admit the superiority of another man. When such a man is placed so that the amount of work he accomplishes is directly measured by the amount some other man does, he will generally do his share.

The greatest amount of work will be obtained from most gangs by treating them considerately, and this policy makes the work more pleasant for both laborer and foreman. "Driving" men is being done away with to a great extent, as it is becoming difficult to keep laborers when such a policy is pursued.

The idea that men should be treated considerately does not mean that discipline must be sacrificed. The foreman's discipline should be strictly maintained under all circumstances. He should personally see to it that each of his orders is obeyed. In case an assistant foreman is employed and the gang is not separated, all orders should in general be given through the assistant foreman. This will to a great extent prevent conflicting orders being given to one man. The

assistant should be backed up by the foreman in all cases in order to maintain his authority.

In order to provide maximum and easy supervision, the men should be kept as close together as is possible, without interfering with each other. The scattered condition of a gang may be due to poor gang organization or to irregularities occurring in the work, and a foreman will show his ingenuity by arranging the work and the laborers so that the gang is kept compact.

A gang of men generally will accomplish more and better work if kept in a good humor. It is advisable to use methods which make the least demands on the strength of the men, provided such methods will not decrease the amount or lower the quality of the work. Men who are treated in this way are apt to become interested in the work and can usually be depended upon, and so require less supervision.

## Broken and Defective Rails, Temiskaming & Northern Ontario Ry.

THE REPORT OF THE chief engineer of the Temiskaming & Northern Ontario Railway shows the following list of broken and defective rails for the year 1910. This railway has a total mileage of 340 miles, of which 252 is main line, 75 miles is sidings and spurs, and 13 miles is branch lines.

Broken and Defective Rails.

| Cause. | No. | Lin. Feet. |
|---|---|---|
| Flaw in base of rail | 2 | 66 |
| | 10 | 328 |
| Crushed head and piped | 4 | 132 |
| | 26 | 1,617 |
| Crushed head | 1 | 33 |
| | 69 | 4,449 |
| Cause unknown | 6 | 396 |
| | 9 | 477 |
| Damaged by engine leaving track | 2 | 66 |
| Soft rail | 1 | 33 |
| Broken by falling rock | 6 | 396 |
| Chipped base, caused by broken car wheel | 1 | 33 |
| Old flaw in web of rail | 3 | 99 |
| | 2 | 66 |
| Rail damaged by broken car wheel flange | 18 | 594 |
| Half moon break in base of rail | 1 | 31 |
| | 8 | 264 |
| | 1 | 33 |
| Split head and piped | 1 | 33 |
| | 63 | 3,063 |
| Split head | 4 | 132 |
| Old flaw in base of rail | 2 | 66 |
| Surface bent by blasting | 1 | 33 |

The number of head failures and defects make up a very large percentage of the whole number. The next largest in numbers occur under "causes unknown" and "damaged by broken car wheel flange." A number are thus seen to be definitely attributable to known defects in rolling stock. The number of failures due to defects such as flat spots in wheels and badly worn tires would probably be impossible to determine, but it seems probable that some of the large numbers reported under the headings "crushed head," "cause unknown" and "split head and piped" might be attributable to these defects in rolling stock.

## Concrete.

THE USE OF concrete for commercial buildings, for dwellings, etc., has shown a remarkable growth. The use of this material by the railroads in different classes of structures has also rapidly increased.

There are many properties of concrete which are of especial value to a railway. Its fire-resisting qualities not only save a loss of the structure in many cases, but also in the case of arches, culverts, and trestles, gives a greater safety to the roadbed and eliminates the danger of serious wrecks which may result in loss of life as well as loss of property, to say nothing of delays occasioned when one of these structures is burned out. Railway structures may at any time be subjected to fire from passing locomotives. Thus, on account of the increased danger of fire, concrete construction should show even greater advantages for railway than for other structures. Another advantage of concrete waterways is their low maintenance cost, and the need for less inspection as compared with structures composed of steel or wood. This is on account of the non-corrosive character of concrete as well as its resistance to fire.

One of the greatest advantages of using reinforced concrete is that it can be made by cheap and unskilled labor. This to a railway company means much, for their construction is frequently carried on spasmodically. A year of great activity may be followed by one of practically no construction. Or one year may see the construction mainly of tracks and yards, while the next year may be one of special activity in re-construction of bridges, etc. With this fluctuating demand, it is much easier to construct with material which needs no skilled labor.

## BEAVER DAM-AGES.

A land company at Stanhope, N. J., recently decided to construct an artificial pond in a section which was being developed, and in building the dam the engineers tore down a dam which had been built at the same spot by beavers. The engineers' work was completed only a short time ago; the beavers in the meantime had remained in seclusion so long that they had been entirely forgotten. A few days later, however, there appeared another and a larger dam of beaver manufacture, below the masonry dam, and before the men awoke to what was going on their new masonry dam was entirely submerged. Inasmuch as the beavers have made a larger pond than the engineers had planned, the latter are said to be inclined to pass by the slight on their work and to accept the gift.

The New Jersey engineers may believe that beaver dams are a good thing, but out near Steamboat Springs, Colo., according to another press report, there is a certain rancher who has a different opinion. Beavers on his ranch have dammed up his irrigation ditch so that the flow of water through his land has been stopped. Not long ago they filled the ditch with such a strong dam that it took two men an hour to demolish it and permit the water to flow unobstructed. The very next night the beavers did another construction job only a few yards from the first. That also was demolished, but to no avail, as the beavers immediately erected another dam. As a final resort, the rancher applied to the State Game Commission for permission to kill the beavers, claiming that unless this was done they would next be damming up Bear River and would thus deprive a number of other farmers of waters necessary for irrigation.—Compressed Air Magazine.

# The New C. & N. W. Ry. Terminal at Chicago

The Chicago terminal of the Chicago & Northwestern Railway* was formally opened June 4, 1910. After five and one-half years of work since the first studies of the general plan were undertaken in December, 1905, and after many unforeseen delays, the structure is complete.

At 6:00 a. m. the entire suburban and through passenger traffic was turned onto the new tracks, putting into service simultaneously five new interlocking plants.

For over a month shuttle trains have been operating over the two interlocking plants nearest the depot; the Lake street plant, which operates the track layouts in the depot yard, and the Jefferson street plant, which operates the tracks at the throat of the yard. On Sunday, May 21, and also on May 28, a number of short passenger trains were made up and sent over the different routes without any passengers in them. The first real train out of the depot was a special, which left the station on May 15, with a number of directors of the road, for the annual inspection trip. Preceding the departure, this party inspected the new terminal building.

It was to be expected with this careful and thorough preparation that the new plant would be thrown into operation and handle the traffic without a hitch. Expectations on this score were fully realized; there were no long delays, and no derailments occurred during the first day's operation.

The new terminal, which is absolutely fireproof, is one of the finest in the United States, occupies four city blocks and is only exceeded in size and cost by the $100,000,000 New York station of the Pennsylvania Railroad. The growing traffic requirements have made this station a necessity. Its capacity is about 250,000 people daily; about 340 trains will be operated into it daily.

Main Waiting Room, New Northwestern Station.

On the street level, the essential feature of the whole floor is the great lobby, or concourse, where all the business of preparing for travel is conducted. The lofty vestibule or portico which forms the Madison street entrance, opens directly into this public concourse, which has an area of 100 feet by 250 feet; through this concourse suburban passengers can conveniently reach the northern part of town.

The train shed floor is of concrete, and in the center are sixteen suburban stairways leading to the streets, without the necessity of passing through the main waiting room.

Adjoining are both public and private carriage entrances and a private entrance with a special elevator for funeral parties.

It is possible for the carriage entrance to accommodate

*See March issue Railway Engineering and Maintenance of Way.

Elevators at Corner of Main Waiting Room, New Northwestern Station.

100 vehicles, drawn up abreast. The entrance is under cover and unhampered by vehicles in the street. In fact, entrance can be made to the depot directly from automobile, carriage or street car, under cover.

Every practical convenience has been put in use for the immigrants by the Northwestern, and from the time immigrants reach the Chicago terminal they are in charge of a Northwestern official.

The immigrants' quarters include a large, commodious waiting room (entirely removed from the main waiting room) which is used for immigrants only. This room is on the street level, with an outside entrance on Clinton street. Opening off of this immigrants' waiting room is a very large room, given over to fifty private bathrooms for their use; also connected with the immigrants' waiting room is a room 50 feet square, containing twenty-five large wash tubs for the use of immigrants in washing their linen.

In this same room is a large drying room, equipped to hold 2,000 garments while drying, and it is connected with the power plant of the station and the clothes are dried in fifteen minutes after being put into the drying room.

There are complete telephone connections throughout the building, both local and long distance. The sanitation in the entire building is perfect. The air is cooled by iced water and pipes, and a continual circulation is kept up at all times. The electric lighting station, which is owned by the Northwestern, was installed at a cost of nearly $1,000,000. In the main waiting room the illumination is reflected; incandescent lamps of 5,000 candlepower are used, yet none of the lamps are visible. Thirteen electric clocks, all wound and regulated from one master clock, are disposed about the building in conspicuous places.

Opening on Clinton street is a private funeral reception hall. Corpses being brought to the stations are not visible to other passengers and are handled by an elevator service which places the coffin directly outside the baggage car. The elevator for this purpose is covered.

Between the sixteen tracks in the trainshed are automatic mail conveyors which deliver mail pouches to the floor level below into Station U, a fully complete postoffice of itself, where all mail to or from points on the Northwestern lines is sorted direct without passing through the main postoffice.

## CULTIVATION OF TREES FOR CROSS TIES.

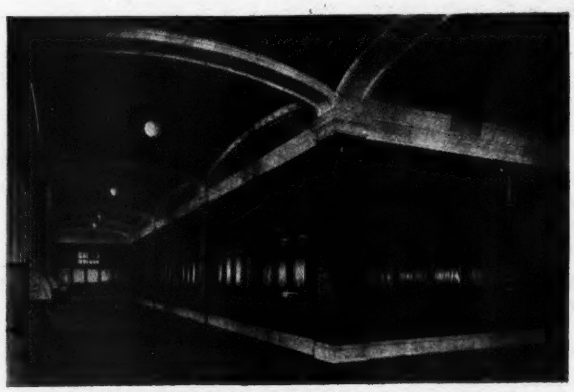
Marked economy has been effected by the Pennsylvania Railroad Co. through its tree planting operations and nursery, according to the report for the year 1910 by the forester of the company. This report also shows that since the company undertook forestry work on a comprehensive scale more than four million trees have been set out. Last year alone 617,338 trees were set in permanent locations on tracts of land adjacent to the company's right of way.

The forestry operations of the company extend to all points on the Lines East of Pittsburgh and Erie. During last year 650 acres of idle land were set out in hard wood and evergreen seedling trees supplied by the company's own nursery at Morrisville, Pa. There were 200,000 trees planted on several of the company's properties at Altoona, 49,189 in the vicinity of Mount Union, 93,700 near Martic Forge, 65,500 at Newton Hamilton, 62,249 at Petersburg, 36,100 near Middletown, 12,000 at Vineyard, 10,000 at Ryde, 27,750 at Rambo, 5,000 at Conewago, 3,500 at Kinzer, 17,250 at New Brunswick, N. J., and 35,100 at Parkton, Md.

There are thirty-two and one-half acres of land at Morrisville, Pa., devoted to nursery purposes, which afford a capacity of one million trees per year. To replace the seedling trees transferred last year to their permanent locations required the planting of 269 bushels of acorns and 116 pounds of seeds from coniferous trees. The total output of the company's nursery during the year was 766,924 trees. The stock on hand at the nursery at the close of the year was nearly one and one-half million forest trees varying in age from eight months to four years, and 137,200 ornamental plants.

Indicative of the scope of the Pennsylvania Railroad's forestry operations—the largest ever undertaken by any corporation—is the following table showing the planting done in the last nine years:

| Years. | Number of trees planted. |
|---|---|
| 1902 | 13,610 |
| 1903 | 43,364 |
| 1904 | 223,656 |
| 1905 | 597,165 |
| 1906 | 801,625 |



Ticket Office, New Northwestern Station.

| | |
|---|---|
| 1907 | 448,226 |
| 1908 | 300,530 |
| 1909 | 1,054,010 |
| 1910 | 617,338 |
| Total | 4,099,524 |

The Pennsylvania Railroad Co. has established two large tie and timber treating plants, both using the pressure treatment, one at Mt. Union and the other at Greenwich Point, Philadelphia. These plants have a combined capacity per year of a million and one-half cross-ties or their equivalent. The Mt. Union plant was in operation the entire year, while the one at Greenwich Point was placed in service July 1st. In 1910 there were treated 671,369 ties, as well as four and one-half million feet of lumber and switch timber, 5,432 fence posts, 10,592 cross-arms, 55,212 lineal feet of poles, and 90,306 paving blocks. To do this required the use of 2,866,513 gallons of creosote oil, all of which was imported from Europe.

Train Shed, New Northwestern Station.

## NEW WOOD PRESERVING PROCESS.

Consul General William A. Prickett, of Auckland, New Zealand, reports to the authorities at Washington that a limited stock company located near Wellington, is now engaged in treating chemically lumber of ordinary quality for railroad ties, fence posts, etc., and the claim is made that the material so treated will last as long as the best wood the forests can produce.

According to a New Zealand journal, the company has established extensive works capable of treating a million feet of lumber per month.

The preserving process is said to be simple and inexpensive, and consists essentially in boiling the wood in a saccharine solution to which certain other substances are added according to the special purpose for which the lumber is required. The lumber is not subject to any external pressure or vacuum at any stage of the process. The wood as it is received is immersed in a cold solution in large open tanks. This solution is gradually raised to the boiling point and is maintained at this temperature for a certain time, depending on the size and density of the wood. After cooling the wood is removed and placed in a drying chamber, the temperature of which is slowly raised. When sufficient desiccation has taken place the chamber is gradually cooled down. The time occupied by the whole treatment generally takes but a few days, though in special cases and for large-sized timber it may be extended for several weeks. The action which takes place is described as follows:

As the temperature of the solution in which the wood is immersed is raised the air in the wood expands and the greater portion escapes in a series of bubbles. As a saccharine solution boils at a slightly higher temperature than water, the moisture in the wood is converted into vapor and escapes along with the air. During the boiling the albuminous matter in the wood is coagulated and rendered inert. In some measure this coagulation accounts for the strength of the wood being increased by the process. While cooling the solution is rapidly absorbed by the wood and penetrates every part of it.

Among the advantages claimed for this process is the statement that the timber can be treated as soon as it is brought in from the woods and then immediately used for the purposes required, whereas in the ordinary way the sawn lumber must be allowed to season for a year or more before being worked up. It is claimed, also, that there is no waste in lumber which has been treated, as the process stops all warpage and splitting, as well as rendering it absolutely immune from dry rot and borer insects.

## RECORD WORK ON RELOCATION, PANAMA.

Six 70-ton and three 105-ton steam shovels working on the relocated line of the Panama Railroad, on April 15, excavated 18,210 cubic yards, an average of 2,023 yards per shovel. Six of these shovels were digging in the barrow pits at Monte Lirio and the spoil was hauled in 10-yard steel dump cars to the fill across the Gatun valley. Three of the shovels were working on the Culebra Cut section and the spoil was disposed of in nearby fills.

# Telephone Train Dispatching and Selective Signaling

**By Edward Backus, U. S. Electric Co.**

What are the reasons for an increase in a twelvemonth of nearly 45 per cent in the mileage of steam railroads in the United States operated by telephone train dispatching, and what wizardry of product is this which is supplanting the telegraph, time-honored in railway service? Economy and superior efficiency is the answer to the first question; the selector and the art of selective calling and signaling, to the second.

The Interstate Commerce Commission report of January 1, 1911, shows a railway mileage of 41,717 operated by means of telephone train dispatching. This, however, includes electric interurban roads which by virtue of intersate operations come under the jurisdiction of the commission. Deducting for these 3,605 miles leaves a total of steam lines in the United States under telephone train dispatching of 38,112, a gain during the year of 11,768 miles, or nearly 45 per cent. And even these figures by no means tell the whole story on this continent, for the Canadian roads have gone extensively into telephone dispatching. Although its total telephone operated mileage is much greater on one system in the United States, the most striking showing on the map is made by the Canadian Pacific Railway, which has over 3,900 miles telephone operated, extending from St. John, N. B., on the east to Kamloops, B. C., on the west, or practically from ocean to ocean. The exceptions on this company's main line are the double-tracked sections.

Although the first telegraph line was built on the right of way of the Baltimore & Ohio Railroad, it was not until about 1850 that the telegraph was used to direct the movement of trains and the first use occurred on the Erie Railroad. The story has become a classic of the telegraph and the incident is about to be signalized by the erection of a memorial at the station at which the first telegraphic train dispatching order was issued.

Various considerations retarded the introduction of the telephone for railroad service. Existing long-term contracts between the railroads and the commercial telegraph companies made their interests identical in some respects. Many of the higher officials of the railroads had been operators, dispatchers or superintendents of telegraph. Their mental machinery had been trained to work to perfection through the instrumentality of the telegraph, which had, up to the general adoption of the telephone, been considered the most rapid means of transmitting information. The first cost of telegraphic equipment was low, as compared with that of telephone equipment, and the change from telegraph to telephone meant additional trouble and expense. Small wonder then, that the higher officials felt that their well-working system was not susceptible of a change of doubtful advantage, when the risks were considered. The telephone business was in the hands of licensees of the American Bell Telephone Company; contracts and rates obtainable showed a wide range, and telephone equipment had to be leased and could not be purchased. By reason of these causes it came to pass that the general public was using the telephone to a remarkable extent before it gained a foothold in the railway service.

Railway telephone service may be divided broadly into three classes: business with the public; business between their own departments and stations; business with other railroads and transportation companies. Train dispatching falls naturally into the second of these classes and may be held to constitute the most important use of the telephone in the domestic economy of a railroad organization. The telegraph had been the standard method of dispatching trains for nearly 60 years, and the block system had grown up around it.

Two considerations were, in the main, operative to secure a hearing for the telephone and for that other device, the selector, which alone made the telephone available in train dispatching service. The Federal government about four years ago enacted a law limiting to nine hours the time of duty of an operator transmitting or receiving orders affecting train movements. Already a growing difficulty had been felt by the railway companies in securing operators competent to care for the natural increase of business. It was estimated that to comply with the provisions of the Federal law fully 15,000 additional operators would be required with an added annual expense of $10,000,000. In addition the efficiency of operators had been steadily declining, owing to the hostility of the telegraphers' organization to student operators.

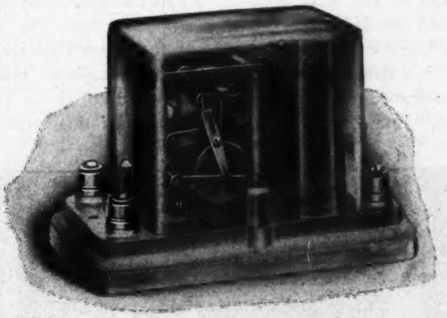
Concourse on Street Level Floor, New Northwestern Station.

Prior to the enactment of this nine-hour law some of the railroads had been experimenting in a crude way with the movement of trains by telephone and in the use of the composite telephone. It was not, however, until the June, 1907, meeting of the Association of Railway Superintendents of Telegraph that the question of telephone train dispatching upon anything approaching the present basis was given serious consideration. It was also a singular commentary upon the state of development of the telephone art, that when the railways decided that they were ready to take up and consider telephone train dispatching, the manufacturers of telephone apparatus had nothing to offer to meet the demand.

It remained for Edwin R. Gill, the electrical engineer of the

United States Electric Company, who had, since the early eighties, been at work on a selective calling device for telegraph service, to adapt his device to telephone calling and dispatching. This, without prejudice to other designers or inventors, must be considered the great progenitor of selective calling for telephone train dispatching, and the device which has made all others possible.

In this system a train-dispatching circuit extends along a division and is used exclusively by the dispatchers for issuing orders regarding train movements and for receiving reports from the operators. The average length of a division may be taken as 130 to 150 miles with 20 to 25 sections or blocks, with an operator for each. The length of division circuit may, however,



The Gill Selector.

exceed these figures. There are several circuits of 300 miles or over; on the Seaboard Air Line there is a circuit of 276 miles with 52 selector stations.

The requirements necessary for telephone train dispatching if it was to supplant telegraph dispatching were: (1) The ability to signal exclusively any one of 50 or more stations on a line which may exceed 250 miles in length. (2) The ability also to communicate with the dispatcher from any one of these stations. (3) An arrangement whereby any number of stations may simultaneously listen in. (4) The means of quickly testing and patching any part of the circuit.

Probably none of the half a hundred railways now using telephone train dispatching will contend that the selective telephone system does not meet, fully and absolutely, all these requirements. In addition it brings other advantages, not possible with the telegraph. Its operation is not restricted to Morse operators. Others concerned with train movements may be made competent operators under telephone dispatching. This feature makes possible the continuous profitable employment of those who by reason of accident may be incapacitated for train service, but who are familiar with the operating rules.

The Gill Selector is shown in the accompanying cut. By it the dispatcher may discriminate or select from among his stations that particular station with which he wishes to communicate, causing at will the selector in that station,—and at no other station on the circuit—to be operated to the contact position and thereby signaling that station by ringing a bell or by causing a visible signal to be displayed.

There are in the market today three general types of selectors operating on differing principles. First are instruments responding only to a certain number and sequence of long and short current impulses, or long and short intervals between impulses. In this class the only instrument in the circuit which will close its contact will be that adjusted to respond to the particular code arrangement of impulses sent over the line.

In another type the station instruments are arranged to be started simultaneously by the dispatcher and to operate independently (but in synchronism) by means of local energy. In this pattern, at a predetermined instant, an impulse sent out over the line finds a path provided through the contact at one station only, the other instruments having either passed their contact points or not having reached them.

A third type includes instruments of the so-called step-by-step principle, which are stepped around in union by a series of impulses, the number of impulses sent determining the stations called.

The makers of that selector which has come into use in the largest number in railway train dispatching service are governed by the conviction that no reliable selective device—applicable to railway work in its fullest requirements, i. e., for the greatest length of circuit and the ultimate number of stations—will be found effective or satisfactory, based on any other principle than that of the combination or code impulse calling.

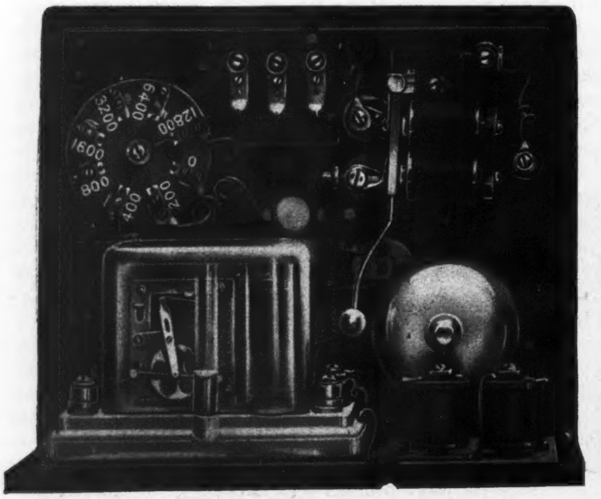
The Gill selector consists essentially of a combination wheel, an electro-magnet the armature of which is arranged to step the wheel forward, a retaining pawl to retain the teeth stepped, and a time element, the function of which is to permit the retaining pawl to assume either one of two positions according to the length of impulse of the current. The time element consists of a metal wheel carried on a shaft of small diameter and so arranged that it can roll on its axis or shaft, down an inclined rod. In the illustration the time wheel and the inclined rod are shown at the left and the electro-magnet at the right. Through the related action of the time wheel and the retaining pawl (by means which it is not necessary to describe here) only that selector is brought to a position to close its contact and signal the station whose combination wheel corresponds exactly to the sequence of long and short impulses being sent over the line. In all other selectors on the circuit the combination wheel has returned to its normal position and the station is consequently not signaled. In operation the Gill selector will call the most remote station on the line in the same time required to call the nearest. It cannot be operated by stray or induced currents from other wires or from the earth, for the operating current must be sent in certain combinations, properly spaced, before the selector will act.

The sending of the proper combination of impulses is accomplished by an automatic calling key at the dispatcher's office. This consists of a simple train of gears operating a circuit breaker, somewhat similar to the district messenger box. One such key is provided for every selector station in the circuit, its specially cut circuit breaker wheel making that combination of code impulses which will bring unfailingly to the contact position the selector in that station having the corresponding code number. No adjustment of keys or selectors is necessary. The dispatcher wears a breast-plate transmitter and a head receiver and is constantly on the line during his time of duty. The dispatcher is shown at his desk in the view appended. This

U. S. Electric Company's Semaphore Box.

illustration is of historic interest as it represents the first telephone train dispatcher's outfit ever installed, that of the New York Central, put in service in the fall of 1907.

The Gill selector is so wound as to enable it to be bridged directly across the telephone circuit and be operated economically without the use of relays or local battery at the stations, and without causing a loss in telephone transmission. When the selector makes its contact the calling bell at the station may be rung either by the local battery or by the main signaling battery at the dispatcher's office. Both methods of operation have points in their favor and both have staunch advocates among their users. The selector is operated by direct current from any convenient source, such as dry cells, storage cells, telegraph dynamos or even direct current lighting circuits. It will operate with absolute reliability on from 8 to 25 milliamperes of current. The illustration shows the interior of a selector box outfit arranged for ringing with the main line battery. The large coil over the selector is a universal resistance coil, affording, according to the connection made, any resistance desired from zero to 25,600 ohms. The smaller coils at the right are retardation coils, connected in series with the selector. They offer additional impedance to lighting discharges.



Gill. Selector Main Line Bell Station Outfit.

The First Telephone Train Dispatcher.

This, without going into the electrical technicalities, is the system which is serving the railroads of the country in a constantly increasing degree. Instances might be given of the great saving of time and money by the use of telephone train dispatching, but it will suffice to state that the Seaboard Air Line—the road with the long circuit and the 52 stations previously referred to—as a direct result of the economy shown by telephone train dispatching in over a year and a half of service, has now given an order for the equipping of more than 600 miles of additional circuits, on all of which the Gill selector will be used.

An entirely new application of the selective calling principle has just been brought out by the United States Electric Company in the form of a dispatcher-controlled train-order semaphore. This is especially intended for single-track roads, steam or electric, and was first exhibited at the Coliseum show in March last. This system comprises a combination of the selector and the electric slot semaphore—both reliable, as has been proved by years of experience—with the addition of a mechanical lock, retaining in the dispatcher's hands the control of a signal once set, and an answer-back; this puts a voice into the signal and causes it to report itself to the dispatcher. Signals may be thrown to the "stop" position by the dispatcher whenever the signals are located or however they are attended. As at present furnished, signals are restored to "safety" by the train crew after receiving orders from the dispatcher and after his electrical consent to the restoring of the signal has been given. The system includes, however, equipment for the restoring of the signal by the dispatcher without the intervention of the train crew.

The semaphore signal equipment consists of a 20-foot iron mast, two double spectacle lenses, blade, oil or electric lamp, electric slot and an answer-back mechanism. The selector equipment consists of a selector, semaphore relay, bell, and induction coil. A 6 or 10-volt battery of the closed circuit type is required with each signal. The signal blade is held in the "clear" position by the magnet in the electric slot being continually energized by the local battery. When the dispatcher desires to move any signal to the "stop" position, he turns the automatic calling key for that station. When the contact of the selector closes, it completes the circuit of the semaphore relay which then operates the slot causing the blade to go to the "stop" position. Immediately on the conclusion of this movement the dispatcher gets, by induction over the telephone wire, a definite, audible answer-back, comprising a repetition of the distinctive number of the signal, and showing that the operated signal has gone to the desired position. When the semaphore has gone to the "stop" position the blade is held by the mechanical lock shown in the lower left-hand corner in the view of the box interior. Against this lock no one can pull the blade down into the "safety" position, nor can any one, by operating the restoring lever reset the signal or force the blade back into the "safety" position.

After orders have been given to the train crew and properly verified, the dispatcher gives permission for the restoration of the signal by reversing the calling battery. This is accomplished by means of a switch, and by again sending the station's call, by the individual key. This will again close the selector contact and open that of the semaphore relay, permitting the signal to be restored to "clear" position.

The system is operated on a closed circuit and is so arranged that any failure of the current supply will set the signal at the "stop" position. When used as dispatcher's train-order signals, but two positions are required for the semaphore. Either upper or lower quadrant signals may be fitted, light signals may be shown in both directions on a single track or separate signals for movements in opposite directions may be installed on a single pole. The selective signaling system may be connected direct to the ordinary dispatcher's train wire without interfering with the service at other stations where semaphore signals are not installed. The system is thus susceptible of additions

and extensions without interference with existing circuits and is capable of conversion at any time into a part of an automatic block system, by the addition of the necessary motor and track relay. No part of the selective signaling apparatus need be discarded in making such conversion.

The dispatcher-controlled signals will work as far as a telegraphic impulse can be effective, and with the selector in daily use on long circuits, as stated, they are believed to be reliable and to constitute a marked improvement in the apparatus for safeguarding traffic on single-track lines.

# Dupo Yard Lighting

By W. S. Austin.

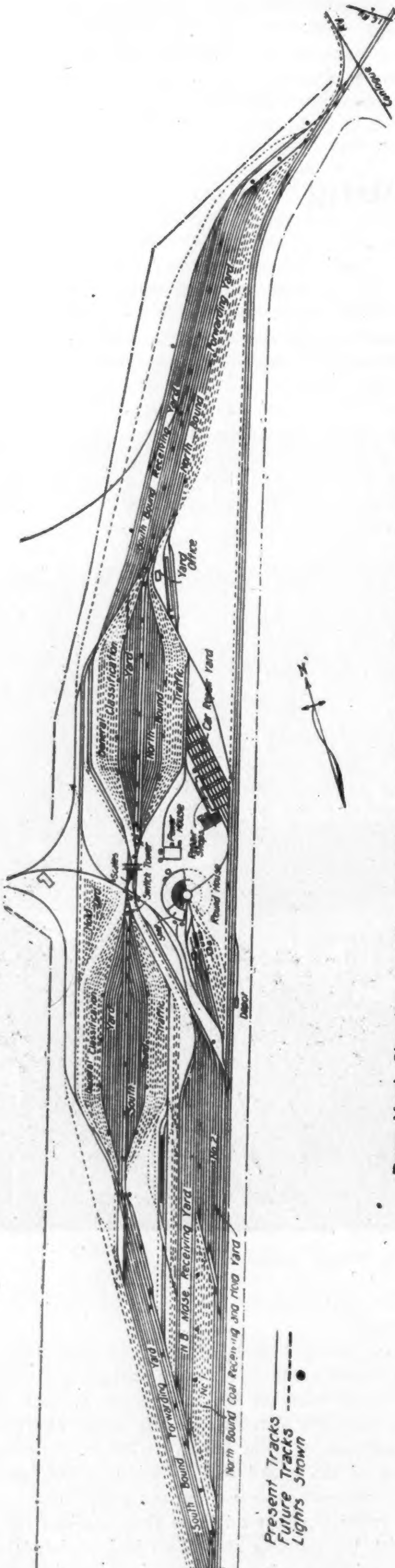
At Dupo, Ill., about thirteen miles southeast of St. Louis Union Station on the St. Louis, Iron Mountain & Southern Railroad, of the Missouri Pacific Railway System, is located one of the largest double hump freight yards in the West, designed to handle both north and south-bound traffic, each hump having a capacity of 120 cars per hour. The yard is about three miles long and about 800 feet wide at the classifying yards, with connections to the railroad company's Illinois divisoin, East St. Louis, Ivory Ferry, the Terminal Railroad Association and other systems. The yard is divided into receiving, classification, forwarding, storage, caboose and repair yards. The two humps, the roundhouse repair yards, coal and water stations, and the power house, together with a hotel and other facilities, are located at practically the longitudinal center of the yard, making it very nearly symmetrical.

Under the direction of the construction department of the Missouri Pacific Railway, Westinghouse, Church, Kerr & Co., in 1906, acting as engineers and constructors for the railway, designed, constructed and equipped its Dupo power house. The following year the engineers were instructed to investigate and recommend a system of artificial illumination for the yard. All of the commercial systems of outdoor arc lighting were investigated but as the power house contained alternating current equipment the direct current systems could not be given serious consideration. Owing to business conditions all work in the yard was suspended from 1907 to 1909 in the fall of which year the subject was again taken up, and, as many improvements had been made in the different lighting systems, another investigation and report was made, which included flaming arcs in addition to the systems previously considered.

Several installations of flaming arcs were visited in and around New York, including those at the Bush terminal yards, the New York Central yards, and a foundry installation. In a portion of the foundry the carbon arcs (which the flaming arcs had superseded) had not been removed, making it possible to study the effect, intensity and quality of light produced by both systems by using first one system and then the other.

Artificial Illumination of Dupo Yard at Round House.

Tests made showed that in direct sunlight an 8-in. high white chalk figure made on a brown background with a ½-in. diameter crayon could be read up to 275 ft., and that on a dark night with the flaming arc the same figure could be read at a distance of from 100 ft. to 150 ft., depending upon the position of the board with relation to the lamp; under the same conditoins with carbon and other white light arcs the figures could not be read more than one-half the distance possible with the flaming arc. This had an important bearing on the selection of a lamp, as in operating the humps it is necessary that the men in the switch towers at the entrances to the classification yard be able to read the car numbers at a distance of from 100 ft. to 175 ft. in order to throw the proper switch in front of the approaching car.

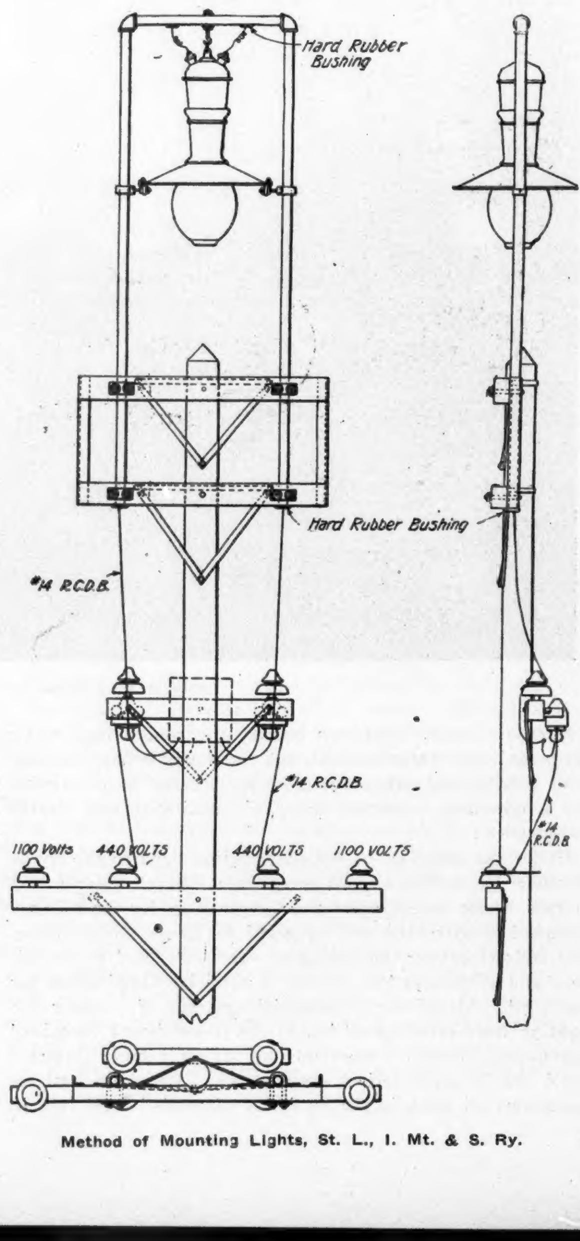



Dupo Yard, Showing Location of Lights, St. Louis, Iron Mountain & Southern Ry.

A detailed investigation and study showed that the candle-power of the flaming arc was greater than that of any other type; that the quality of light generated by it was better suited for this installation than that produced by any of the other lamps, as the penertation in clear weather as well as in smoke and fog was greater than with any of the other types; and that it had the further advantage that the unshaded lamps would not blind or dazzle the eyes of the switching crews while working around the yard, even though they looked directly at the lamp or beyond it, thus making it unnecessary to provide expensive and complicated reflectors and shades.

A comparative study of the different kinds of flaming arcs was made to determine reliability, freedom from interruption, length of burning between trims, cost of operation, repairs, maintenance, etc., with the result that the regenerative flaming arc manufactured by the Adams-Bagnall Electric Co. was recommended for this installation.

A drawing herewith shows the outline of the yard and spacing of tracks, as well as the approximate location and spacing of lamps. The lamps are spaced closest around the humps and the distance between the lamps increases through




Method of Mounting Lights, St. L., I. Mt. & S. Ry.

the classification yard and out into the forwarding and receiving yards, where some of the lamps are spaced 600 ft. A spacing of 400 ft. was found to give a very satisfactory illumination for general work with the lamps located 40 ft. above the rails, making it possible for men standing on the cars to see underneath the lamps.

The problem of locating the different lamps was worked out in conference with the railway engineers, and when the system was put in service it was found necessary to move but one of the lamps; this was not to change the distribution of light, but on account of one of the poles obstructing the view of the towerman. This being the first large installation of flaming arc lamps in a railroad yard in this country, no data was available that could be used as a guide in locating the different lamps.

The entire installation, including distribution and erection of poles, feeders, etc., was made without interfering with the operation of the yard and without any one being injured.

The different types of lamp suspension were considered, with the result that the lamps were installed in pole tops designed for the installation, as shown in one of the drawings. The arrangement of circuits is such that two ways are provided for supplying current to the lamps on the humps and in the classification yards. No duplication was attempted for the other yards, where cars could be moved without artificial illumination, if necessary.

The intensity of illumination secured equaled all expectations, and when the lamps were started up in the north half of the yard the effect produced was such that engineers on trains crossing the Eads and Merchants bridges, twelve miles away, could plainly see the illumination, and residents as far distance as ten miles telephoned to ask what was burning at Dupo. Since the system has been put in operation it has been possible to secure results in operating and policing the yards at night such as have never been approached elsewhere. The photograph shown was taken at night and shows something of the intensity of illumination secured.

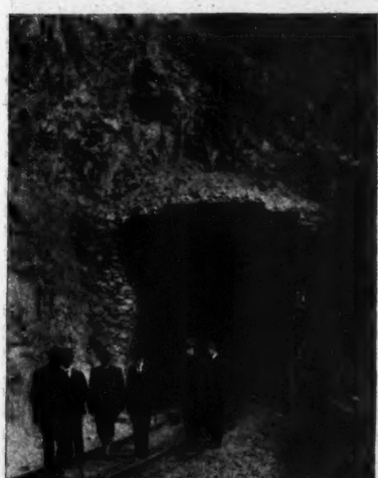
At the present time this yard is, without question, the best artificially illuminated railway freight yard in the country and the only one in which the results obtained give anything approaching a uniform intensity of illumination over the entire area.

# Unusual Washout on San Pedro, Los Angeles & Salt Lake R. R.


Inspection Trip on the Pioche Branch. R. K. Brown, Eng. M. W.; H. E. Van Hansen, Supt.; W. Deford, Rdm.

The San Pedro, Los Angeles & Salt Lake R. R. runs through Meadow and Clover valleys for a distance of 113 miles. In Meadow valley there is a stream which usually is a very insignificant waterway, and when the road was located in 1889, no discouraging construction features were found. The sides of the valley were steep and abrupt, but there was usually room for the track between the cliffs and the edge of the stream. The stream frequently almost entirely stops flowing in dry seasons; in many places the water sinks entirely into the soil, forming an underground river and leaving the channel above it dry. In view of these facts no especial trouble was expected from high water, especially as settlers who had been located in the valley for 12 years reported no serious trouble in that time.

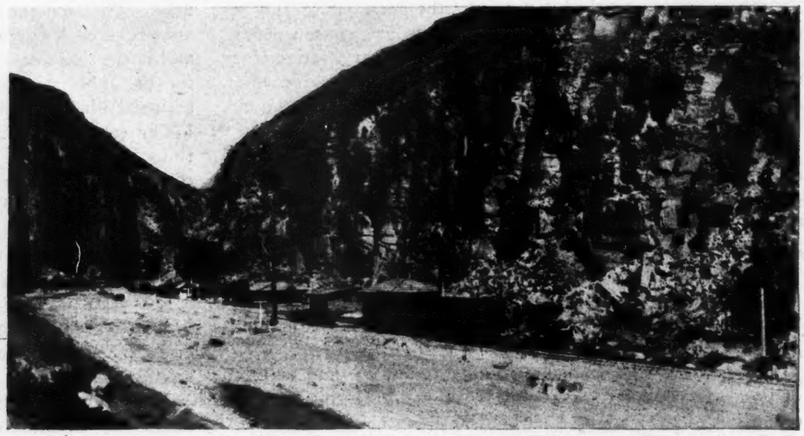
Of the entire line only about one-sixth necessitated heavy construction work, and this was near the summit where there are a number of rock cuts and six tunnels. As is usual in a new line, timber trestles and pile bridges were used to a large extent in the initial construction of the road, and the life of these structures, not having been reached, many of them were in use in 1909, not having been replaced by permanent construction.



Right to Left: R. K. Brown, Eng. M. W.; R. E. Wells, G. M.; E. G. Tilton, Chf. Engr.; H. E. Van Hausen, Supt.; Tunnel Inspection Trip.

Meadow Valley, Wash., Showing Normal Flow of Water, and Precautions for Confining Stream to Its Bed in Flood Time.

Officer's Special at Tunnel Portal,



Elgin Yard, Stream at Normal Flow, San Pedro, Los Angeles & Salt Lake R. R.

The tunnels near the summit were short, aggregating about 2,500 ft. in length. A good deal of heavy cutting in solid rock was necessary on this section. A large part of these cuts and tunnels are on rather sharp curvature, which would be expected in such a rough country. In such places the track ahead is frequently entirely obscured from the view of the locomotive engineer. We show herewith a photograph of some of the officers on a tunnel inspection trip. They are making a rather detailed examination and are followed on foot by a special train, of which we show two photographs, each at the portal of a tunnel. The photograph of the officials on the gasoline car was taken on an inspection trip on the Pioche Branch.

The whole line was completed in 1905. In 1906 there came a small flood which did some damage and closed the road for two weeks. The direct result of this interruption of traffic was the extensive rip-rapping of some of the more exposed grades, and construction designed to restrict the stream to its channel in case of future floods.

In 1907 came the greatest flood ever known in the valley. The stream, which is usually a mere creek, became an immense river. The stream is unusual in that, in spite of its insignificance, it drains an area of upwards of 1,600 square miles; most of this is rocky and devoid of vegetation, with steep slopes. The conditions are almost ideal for the rapid run-off of the greater amount of a rainfall in a short time. To offset this, the region is one of light rainfall.

An unusually heavy fall of snow occurred late in the winter of 1909, and covered the large drainage basin of the Meadow valley. On this unusually heavy snow fall there came a great fall of warm rain, which would probably have caused some trouble of itself. The snow, which under ordinary conditions would have melted slowly and passed off without causing damage, melted in a day, and combined with the heavy fall of rain to form a flood of a magnitude hitherto unrecorded in the valley. The ground surface being rocky, would usually absorb but little of the surface water; at that time of the year (January) it was frozen and would absorb practically none.

An idea of the difference in the usual size of the stream and its size during the flood may be obtained from a comparison of the accompanying illustrations. Even these do not give the complete contrast, for the pictures showing the flood flow were taken after the stream had subsided appreciably. The maximum volume of water was about five times that of any previous known flood.

Flood Flow Subsiding.

Heavy Rip Rap, Afterwards Washed Out. Normal Flow of Stream.

As is quite frequently the case, great damage was done to the bridges and other structures by the accumulation of driftwood against them, and the final damming up of the stream. When one structure gave way, its mass was added to the material which lodged against the next structure down stream, and thus the destruction went on down the valley.

In two of the accompanying illustrations the track is shown

Tunnel Inspection Trip, Special Following Officers.

Bridge Between Kyle and Leith, Washed Out Twice, San Pedro, Los Angeles & Salt Lake R. R.

sagging down over a long channel. The track shown in the first of these was originally supported by a timber trestle which was entirely destroyed. In the second illustration, the track was originally on a high embankment. The timber trestle as well as the embankment was swept completely away and the suspended track left.

The method of laying a temporary track around a place where the grade was destroyed is shown in another illustration. A new track or "shoo fly" was built, starting back near the beginning of the embankment. The track was laid on the surface of the ground, and off to the side of the old center line. This allowed the resumption of traffic without waiting for a new grade to be built. The destruction caused is illustrated by the two pictures of a steel span bridge. The first shows the structure just after its completion, while the second shows it overturned. This bridge has been washed out twice.

Diminishing Flood Flow, Main and Side Track Washed Out.

Bridge Carried Away, Leaving Track Suspended.

Embankment Washed Out, Leaving Track Suspended.

Washout on San Pedro, Los Angeles & Salt Lake R. R.

In the reconstruction of this line, which has gone forward with great energy, about 60 miles of the track has been put on a new location, at a grade from 10 to 12 feet higher than the high water mark established by the recent flood. The track has been made of heavier steel and the entire new equipment is more substantial and of a higher grade than the old.

## CONSTRUCTION OF CONCRETE FENCE POSTS.*

Many things have contributed to make concrete one of the leading building materials of the day. It has shown its worth as a substitute for wood because of its moderate cost, its durability, the ease with which it is handled, the wide distribution of sand, gravel and stone which enter into its composition, and the tremendous growth of the cement industry. It has been thoroughly tried and tested, not only in laboratories, but also by years of actual use by the United States Government, by state agricultural colleges, by railroads and stock yards, and by hundreds of farmers, and it has, among other things, proved successful in the construction of fence posts.

### Comparative Advantages of Concrete and Wooden Fence Posts.

As a material for the construction of fence posts, concrete has not only very few of the disadvantages and practically all of the advantages of wooden posts, but it is also superior to timber in some respects. In the first cost concrete posts may be more or less expensive than the best wooden posts, according to the locality. This depends upon the timber supply, the deposits of gravel and rock, and the skill exercised by the person making the concrete posts.

If manufactured as usual and cured for three months, concrete posts are as good as the best wooden posts of the same size. After three years' service wooden posts possess only from one-third to one-half of their original strength, whereas concrete grows stronger with age and needs no repairs, for neither weather nor fire injures it. Under ordinary circumstances, good concrete posts will last forever; and even if a few, in the course of years, should be broken by un-

*From a bulletin of the U. S. Department of Agriculture.

Building Track Around a Washed Out Grade.

Bridge (shown above) Tipped Over by Washout, San Pedro, Los Angeles & Salt Lake R. R.

usual strains, it is cheaper to replace these than to replace an entire fence of decayed wooden posts with posts of material with the same lack of durability.

Concrete posts are attractive in appearance because of their uniformity of size and color and, because of their durability, they effect a saving in giving greater life to the fencing material used, so that the permanent value of the property is increased.

**Curing.**

It is a great mistake to believe that, when the molding is done, a concrete post is finished. The quality of the post must be determined by curing. The green post should be left in the mold until thoroughly hardened; that is, usually for two or three days. For square or nearly square posts the molds proper may then be removed and used on another bottom board, but the posts must stay on their bottom board in the shade and must not be disturbed for at least a week or ten days. Posts in triangular molds may be carried out, each in its own mold, after from five to seven days, and the post may be gently slid from its mold to a smooth floor covered evenly wtih a cushion of sand. While green the strain of lifting, or even a slight jar, will cause cracks, sometimes invisible, which greatly weaken the post. During the first two days of the life of a post it must be kept wet and covered with canvas, burlap, carpet, or other clean material. The sprinkling should be continued up to the eighth day. After the tenth day, if the space is needed, the post may, with care, be placed on end in the same manner that wooden fence rails were formerly piled. A drop of only 6 inches often breaks a green post. The jar in hauling to the field over rough, frozen roads or in a wagon bed with a very uneven bottom has seriously injured posts which were not well seasoned. Concrete posts gain rapidly in strength for the period of one year; they should, therefore, be made as long as possible before it is necessary to set them in the fence. No post should be used until it is at least three months old, and, to meet any contingency, a supply of well seasoned posts should be kept on hand.

# Reinforcement of Pecos Viaduct*

W. H. Alderson.

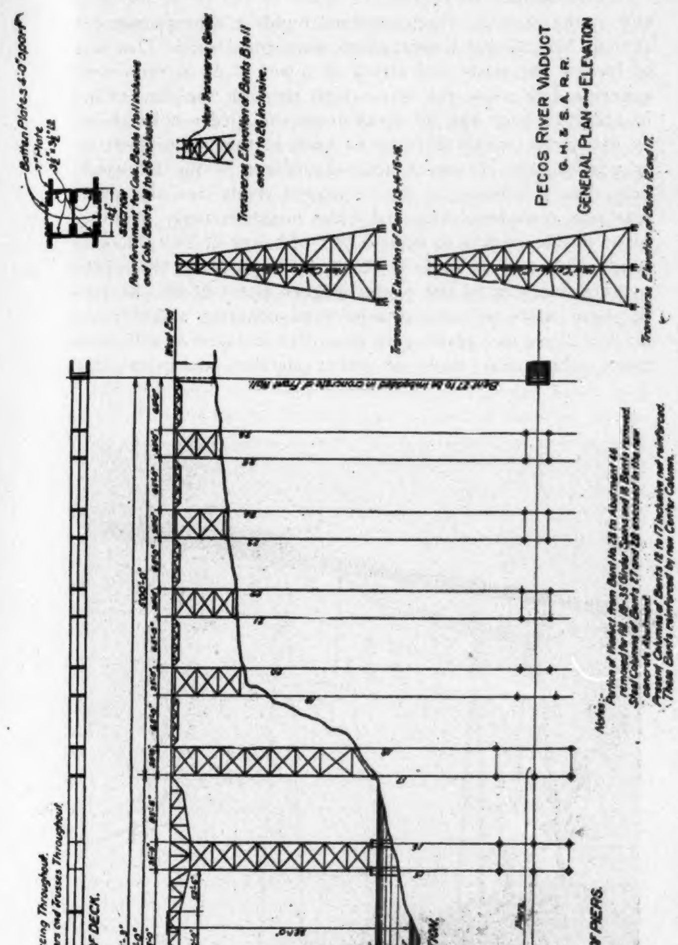
The Pecos viaduct in Texas was built in 1891. Before that time the main line of the Galveston, Houston & San Antonio Ry. (now part of the Southern Pacific Ry.) made a detour to the mouth of the Pecos River, a few miles below the viaduct, crossing the river on an ordinary deck structure just above high water. The old line was expensive to operate on account of heavy grades and curvature and was also expensive to maintain for the same reasons and on account of the unstable nature of the rock in the cuts. As large masses of rock frequently fell in the cuts, it was necessary to keep the track patrolled continually.

The viaduct is 321 ft. above the river and ranks among the high bridges of the world, being for many years the highest bridge in this country. It consisted of thirty-four 35 ft. deck plate girders; one 45 ft. deck plate girder; eight 65 ft. lattice girders, with a central truss of two 85 ft. anchor arms; two 52½ ft. cantilever arms, and an 80 ft. suspended span, making a total length of 2,180 ft. All the towers were 35 ft. long. The trusses and girders are on 10 ft. centers throughout. The total amount of metal was 3,640,000 lb. All the columns except those in bents 13 to 16, supporting the cantilever trusses, consisted of four 6-in. Z-bars. The columns in bents 13 to 16 were two built channel sections laced together. All material was iron except the Z-bars in columns, which were of steel. The bracing of towers was of diagonal rods with horizontal struts of four angles laced, forming an I-shaped section. The lateral bracing of girders and trusses was of rigid members throughout. The lateral bracing on the trusses was composed of members built of four angles, laced, making an I-shaped section of the same depth as the chords. The sway bracing on the cantilevers had diagonal rods with horizontal struts consisting of four angles.

The viaduct was built by the Phoenix Bridge Company and was designed for a live load of 5,000 lb. per ft., with a concentration of 30,000 lb. The old structure was found to be in excellent condition, as it had been carefully maintained; all trains had to come to a full stop before crossing it, and the speed over it was reduced to about ten miles per hour.

For several years the lightness of this structure seriously handicapped the economical operation of the road by limiting the size of locomotives which could be used, and it was desired to reinforce the structure for the present standard loading of the Harriman Lines, which is about equivalent to Cooper's specifications E-55. It was necessary that

*A paper given before the Western Society of Civil Engineers.




the work should be done under traffic, and several schemes were considered for reinforcement.

For the 35 ft. girder spans it was first proposed to put in false work for about three spans from either abutment, removing these spans to either bank and there adding the necessary reinforcing steel, after which these spans could be substituted between trains for three other spans, the spans taken out, reinforced, and substituted for three more, and so on until all spans were reinforced, the last three being placed in the panels where the falsework was used. But when the 35-ft. spans at the ends of the anchor arms were considered, it was found impossible to get them out on account of the details at the ends of the anchor arms. The cantilever trusses required a very large amount of metal to be added, a large number of old rivets to be cut out, and new holes to be drilled. For these reasons it was decided to put in new center cantilever trusses and new 35-ft. girder spans adjacent to the anchor arms.

The 65-ft. lattice girders were found to require a very small amount of reinforcing—principally for strengthening the details and reinforcing the top chord for transverse stresses. Plans were made which would allow of doing this work without interfering with traffic or weakening the spans while reinforcing them.

New center girders for all of the 35-ft. spans were then considered. This required considerably more metal than for reinforcing the old spans, but did not involve the expense of removing the 35-ft. spans. It was considered undesirable to have three girders for all the 35-ft. spans and cantilever trusses, and two girders for the 65-ft. lattice girder spans, so it was decided to put in a center line of girders and trusses for the whole length of the structure, even though the 65-ft. spans could be easily reinforced. The most logical way to carry the load from the center girders to the columns was found to be by means of transverse girders at the tops of the bents, and that plan was adopted. These transverse girders were made double, each half being riveted to the face of the columns, with a diaphragm placed in the center connecting the two halves. While the existing bracing was sufficient in amount, the time and expense of cutting it to clear the center trusses and girders, as well as making connections, rendered its use impracticable, so new lateral bracing for all spans was decided upon. New X-frames were used between the center and outside girders.

For the cantilever trusses the new sway braces had diagonal rods, except at the inclined posts at the ends of the anchor and cantilever arms, which had diagonals made of rigid members. These rods were in pairs and were threaded on the ends, having nuts bearing on lug angles riveted to the faces of the posts of the old trusses. This permitted the new rods to be put in place and tightened up before the old ones were removed. The posts on the center truss were slipped in between the rods, but not connected to them, so that the center and outside trusses could deflect independently.

The center 35 and 45-ft girders were made the same depths as the old outside girders. For the 65-ft. lattice spans new center plate girders were used, which were the same depth as the old spans, and were reduced to 4 ft. at the ends in order to be the same depth as the adjacent 35-ft. spans. The new cantilever and suspended-span trusses had the same outlines as the old trusses, but were made riveted instead of pin-connected.

The new center girders and trusses were designed to carry five-eighths of the load on the track, that being the proportion carried to them if the ties acted as continuous beams. The old trusses and girders were found, after careful checking, to be safe for one-quarter of the load on the track, which load would be carried to them if each half of the tie acted as a single beam. It was thought that the real action of the tie in dis-

tributing the load would be somewhere between these two assumptions.

The Z-bar columns were reinforced by adding four 3½ by 3½ in. angles, and if this did not add sufficient section, four 7 in. plates were also added. At the horizontal struts in the lateral bracing the plate was notched around the same, and the outstanding leg of the angles was cut off. The section was made up by putting on an angle riveted to the flange of the Z-bars with its outstanding leg in the same place as the Z-bar web. Batten plates were used connecting the reinforcing angles to stiffen the columns. These plates were made long enough for three rivets and were placed 4 ft. apart. The transverse girders at the tops of the bents had connection angles riveted to the outstanding flanges of the Z-bars.

Shelf angles were provided to facilitate the erection of these girders. When the columns in bents 12 to 17, supporting the cantilever trusses, were considered, it was found that so much metal would have to be added it was practically impossible to reinforce them. These columns were found to be of sufficient section to carry the load on the outside trusses, so it was decided to add a new center column to these bents. It was found that the columns in bents 11 and 18 would have to be reinforced even if new center columns were added, so it was decided not to use them in these bents. The new center columns were made of two plates and four angles, or of two built channel sections. They were built in halves in the shops, and the lacing and batten plates were riveted on the field. This made it unnecessary to cut any of the old bracing, except the longitudinal struts on the center line of the bridge.

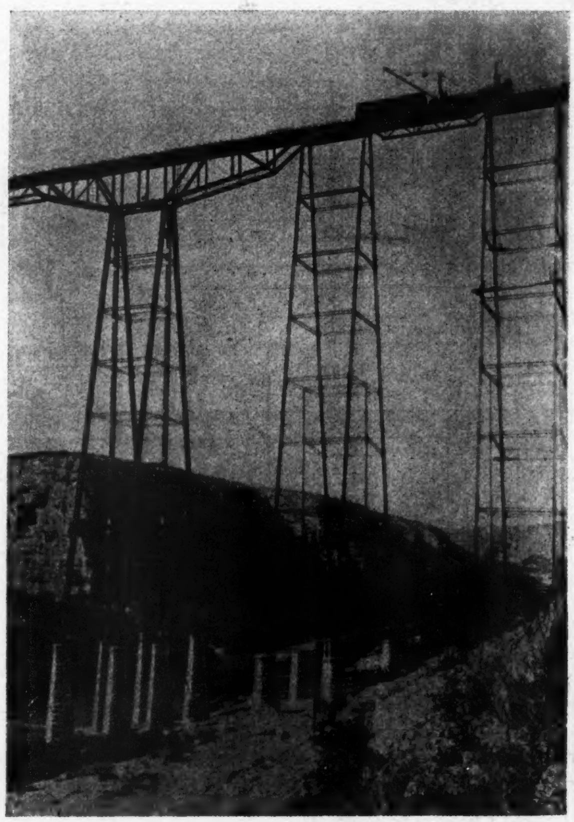
The highest bents had a vertical strut on the center line of the bridge for about half their height, and the old strut was inclosed by the new center columns. These new center columns were braced laterally by being connected to the old horizontal struts, but not to the diagonals. The two center columns in a tower are braced longitudinally by a system similar to that of the outside inclined posts. In bents 11 and 18 the old center vertical strut was extended up the full height of the bent and connected to the center columns in bents 12 and 17 by a system of longitudinal bracing similar to that for the center columns in bents 13 to 16.

The old tower bracing consisted of diagonal rods and horizontal struts of four angles laced. Rods and struts were found to be of sufficient section to carry the wind stresses, and as they had developed no weakness under heavy traction stresses, it was considered safe to leave them in and not put in new bracing. The tops of the new center columns at the ends of the anchor arms have a short length of stub column made to telescope into the main column section, the holes for connecting the top section being drilled in the field. This allowed a vertical adjustment of the links at the ends of the anchor arms. At the ends of the old anchor arms there was a short link pin connected to both the truss and the column. A similar detail was used on the new truss. These links were made in halves so that the pin could be set in the end of the truss and the halves of the link slipped over it, as there was not room enough to drive the pin through both link and truss.

For supporting the center column, an A-frame or truss carrying the load to the existing piers was considered, but it was found impracticable to get a bearing on the old piers, not on account of the piers being too small, but on account of their being placed diagonally to the center line of the bridge. For this reason new center piers were decided on.

The new piers are similar in shape and size to the old ones and, like them, were made diagonal to the center line of the bridge. Their tops are 2 ft. below the tops of the old piers to allow the base of the new column to clear the old bottom strut of the bent. This base was made in halves, like the rest of the column, the two halves being connected by field rivets through the outstanding legs of the vertical angles on the wing plates.

It was decided to remove 19 spans or 665 ft. of the west end of the viaduct, which involved building a new abutment at bent No. 27, and several plans were considered. One was to inclose the posts and struts of tower 27-28 in reinforced concrete and allow the fill to spill through the tower, and in order to keep the fill away from the girder a bulkhead, or back wall, would have to be built at the top of bent 28. It was thought, however, that settlement of the fill would bring heavy stresses on the horizontal struts, and the whole plan was considered very risky and unsatisfactory. Another plan considered was to make a box of tower 27-28 by making reinforced concrete walls in the planes of bents 27-28 and the inclined surfaces of the posts between bents 27-28, the tops of these walls to carry a reinforced concrete slab for the track. These two plans were discarded in favor of a U-abutment, which was made of rather slender dimensions and



**Pecos Viaduct, Showing New Center Columns Supporting Cantilever Trusses.**

would have been made a pier in the middle of the fill but for the necessity of keeping the toe of the fill away from the steel of bent 26. As finally built, this abutment was 55 ft. high and has a base about 3/10 of its height. The wing walls were 17 ft. long from the face of the back wall, and bent 27 was imbedded in the abutment. While the abutment is very tall and slender, it is considered safe as the fill is made of rock, and that part of the fill in front of and around the abutment was very carefully placed, so as to eliminate any tendency to slide.

In carrying out this work in the field it was desired that unnecessary chances were not to be taken in order to hasten the work; at the same time it was also desired not to delay traffic unnecessarily, and in order that the contractor for

erection should be fully familiar with train movements, the railroad company stationed a telegraph operator at the bridge site.

The material as received from the shops was sorted out and stored near the east end of the bridge, some temporary side-tracks having been put in for this purpose. The contractor set up an air compressor with a 4 in. pipe leading half way across the bridge, but reduced it to a 3 in., and later to a 2 in. pipe. At the center of each tower a 2 in. pipe led vertically downward from this main, and Ts were put in at each panel point in the tower, from which a hose connection was made to the riveters and drills. A derrick car was made by mounting an engine and an ordinary boom on a flat car, the boom having a reach of 40 ft. from the front of the car and a capacity of 10 tons. The material for reinforcing the Z-bar columns was first distributed to proper bents and clamped in position. Drilling was started at the tops of the bents and progressed downward. A scaffolding was used for the drillers and riveters, which consisted of a longitudinal timber against the inclined legs of the tower. Across these, at the ends, were short timbers transverse to the bridge and against the face of the bents. At the intersection, diagonal planks were laid, forming a small platform around the column. This scaffolding was raised, when necessary, by the derrick car used for placing the steel.

The general procedure in reinforcing a column was to have a drilling gang at each column on one side of a tower, which worked downward for about one-third of the height of the high towers. The scaffolding was then raised to the top of the tower and riveting was done for the upper third; then the middle and lower thirds were finished in the same way. By having several sets of scaffolding it was possible to carry on reinforcing of several of the towers at once, drilling and riveting gangs being shifted from tower to tower as necessary. The material for center columns and transverse girders was lowered over the side by the derrick car; in the case of low towers, it was laid on the ground until a line could be dropped through the deck of the structure; the material was then carried up into its final position. In the case of high towers the material was held by one line until another could be dropped through the deck, when the material was picked up and hoisted in position as was done for the lower towers.

For placing the 35 ft. girders and all of the cantilever trusses except the bottom chord, it was necessary to remove the floor of the bridge. This was done for one span length at a time, and did not interfere with traffic over the bridge. The 65 ft. center girders weighed 18 tons and therefore could not be handled by the derrick car alone. By lifting one end of the girder, cribbing up just beyond the center of the span, letting that end of the span drop, cribbing up the end, and then raising and cribbing up the center a little more, these spans were gradually raised to the height of the flat car and skidded on to two cars. A gallows frame, having a set of falls leading from each upper corner, was built which could be placed on the top flanges of the old outside girders. An idler flat car, with a snubbing post on each side, was then placed between the locomotive (which was placed at the disposal of the contractor) and the two flat cars carrying the 65 ft. girder. By slacking off on one line or the other of the falls, the girder could be swung from side to side. This gallows frame was set by a derrick car, and the derrick car then moved off the structure, when the locomotive and three flat cars were moved out into position. One end of the girder was picked up by the two lines from the gallows frame which passed around a sheave at the bottom of the frame and led out horizontally to the snubbing posts on the flat-car idler. By pulling ahead with the locomotive, this end of the girder was lifted, the derrick car raising the other end, when the flat cars on which the girder was loaded were pushed out through the gallows frame by hand. A small wooden pedestal was built which now supported the end of the girder raised by the derrick car, the other end being held by the lines from the gallows frame. The derrick car then removed the ties and rails from the 65 ft. span and the center girder was lowered in position from the gallows frame and derrick car, the total operation taking fourteen men about four and one-half hours.

The new cantilever trusses had the lower chord placed first, and the contractor was allowed to cut only one panel length of the lateral bracing at a time. The chord was suspended from the old structure by means of 12 in. by 12 in. beams. The web members were then placed for a few panel lengths and the upper chord lowered over them. As mentioned before, the new diagonal rods were put in place and tightened up before the old rods were removed and the new vertical posts slipped between them. In this way the cantilever was gradually built one member at a time, the new center trusses being supported from the old structure. Closure was finally made by wedging up the new center trusses.

The reinforcing material was fabricated by the Phoenix Bridge Company, and the erection was done by the Missouri Valley Bridge & Iron Company. The amount of reinforcing-steel added was about 2,200,000 pounds.

As a whole, the entire work was very satisfactory. Plans for reinforcement were prepared by the writer under the direction of Mr. John D. Isaacs, Consulting Engineer of the Harriman Lines. Mr. D. K. Colburn, Bridge Engineer of the Galveston, Houston & San Antonio Ry., had supervision of the erection.

## REINFORCED CONCRETE POLES.

**By R. D. Coombs and C. L. Slocum.**

The increasing demands of the telephone, telegraph, light and power companies, and the wide development of electric traction, together with the increased scarcity and cost of good timber poles, has compelled engineers to look for a suitable substitute possessing the desirable qualities of wooden poles, but without the necessity of continual maintenance and frequent renewals.

According to a report of the Forest Service, United States Department of Agriculture, the telegraph and telephone companies purchase about two-thirds of the total number of timber poles used each year. The remainder may be credited to the steam and electric railroads, and the electric light and power companies. The total number of timber poles over 20 ft. in length purchased in 1906 was reported as 3,574,666, and their value, at the point of purchase, as $9,471,171, or an average of $2.65 per pole. In Fig. 1 are shown the number and average value, at the point of purchase, for varying lengths of the five leading varieties of timber. Other varieties, and the sawed poles of the varieties given, are omitted from the table, since their combined number is relatively small.

By far the greater number of poles are cedar and chestnut, and, as the former grow in the lake states, Maine, northern New York, and Idaho, and the latter in Pennsylvania, Maryland, Virginia and West Virginia, the item of freight to be added to the tabular value may be a considerable factor of the final cost. The rapid increase in the cost of timber—which, as shown by Fig. 1, is still further increased for long lengths—and the deterioration of unpreserved timber, have forced purchasers to consider the use of other methods and materials.

In its function as a carrier of wires a pole resists downward, lateral, and, to some degree, torsional forces. A little strength against compression, a superior resiliency, and a

long life in a variable climate and soil, are the chief requirements of a good pole.

Until recently wooden poles have been so cheap that the advisability of using a wood preservative to delay decay has not been widely or seriously considered, and because the expense of treating the entire pole exceeded the additional benefit or life attained. In addition, many poles have to be renewed not only on account of decay, but because poles of larger capacity are required. The future demands upon an installation cannot always be foretold with accuracy. The duration of the useful life of a timber pole, in contact with the soil, depends in part upon the chemical action of the ingredients of the earth and upon its ability to resist local insect life. Disintegration will, therefore, advance more rapidly in some soils than in others, but in general the use of native timber for local use will be found advisable. The zone of decay at the ground-line is produced by alternate wetting and drying, inducing a condition of decay which frays away the body of the pole until this critical section is so emaciated that it will no longer sustain its load. In the dry season this decayed portion is much in the nature of dry tinder, and if the pole is located on a grassy right

| | Length 20 to 25 Feet. | | Length 26 to 30 Feet. | | Length 31 to 35 Feet | | Length 36 to 40 Feet | | Length 41 Feet and Over. | | Totals. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Average Value. | Number | Average Value. | Number | Average Value. | Number | Average Value. | Number | Average Value. | Number. | Average Value. |
| Cedar | 1,305,148 | $1.19 | 408,139 | $3.22 | 262,739 | $4.94 | 123,391 | $6.17 | 70,452 | $9.08 | 2,169,869 | $2.57 |
| Chestnut | 404,877 | $1.42 | 265,315 | $2.52 | 184,028 | $3.35 | 75,108 | $4.64 | 57,975 | $7 08 | 987,303 | $2.65 |
| Pine | 77,730 | $1.68 | 30,520 | $3.18 | 25,914 | $4.84 | 15,828 | $5.13 | 12,609 | $12 41 | 162,601 | $3.63 |
| Cypress | 27,041 | $1.09 | 40,263 | $1 24 | 22,700 | $3.04 | 14,101 | $4.42 | 7,187 | $6.28 | 111,292 | $2.30 |
| Juniper | 24,063 | $1.62 | 12,003 | $2.70 | 10,638 | $3 68 | 4,113 | $4.09 | 6,247 | $5.76 | 57,064 | $2 86 |
| Totals | 1,838,859 | $1 27 | 756,240 | $2.86 | 506,019 | $4.24 | 232,541 | $5.50 | 154,470 | $8.33 | 3,488,129 | $2.60 |

Fig. 1. Table for Round Poles.*

of way, grass fires char away still more of the critical section. An application of coal-tar to this portion of the pole, while proper in desert localities, would promote the early destruction of the pole in places subject to running grass fires.

Preservative treatment and the consequent use of inferior grades of timber will no doubt afford temporary relief, but it is entirely probable that within the next decade some form of artificial pole will be able to compete in first cost with the wooden poles then available. In case it is necessary to use long, heavy poles, or if the character of line is such that safety and permanence are prime requisites, it will frequently be economical to use reinforced concrete poles.

In addition to the timber poles there are used each year a relatively small though increasing number of metal poles. Steel poles or towers are coming into more general use for power transmission lines, particularly as applied to long spans or high poles. Until recently such steel towers have been built of the lighest sections, often from ⅛ to ¼ inch in thickness, and thus requiring great care in handling and frequent painting. As a rule, structures exposed to the elements are not given frequent attention, and are only repainted after oxidation has occurred to a marked extent.

During the last few years steel transmission line poles of substantial construction, using sections whose thickness and length ratios are in accord with the best modern practice, have been built by several of the large eastern railroads. Some of the lines referred to carry a large number of heavy wires, and for this and other reasons were not well adapted to the use of wooden poles.

Since steel is comparatively expensive and requires maintenance to prevent corrosion, considerable attention has been given to the use of reinforced concrete poles for both telegraph and transmission line construction.

*United States Forest Service, Circular No. 137.

When steel is embedded in well-made concrete its preservation is perfect, and the life of a reinforced monolith is practically indefinite. If designed and built with the same attention now given other materials, reinforced concrete poles should attain the necessary strength and give satisfactory service. As in the case of steel poles, they can be spaced greater distances apart than is economically possible with wooden poles, and in their fire-resisting qualities are at least equal to steel poles. This latter feature will become of increased importance with the spread of modern requirements for fire protection.

Concrete poles are of a pleasing gray color and are readily modified in outline, or in the treatment of the base, to suit the locality in which they may be situated.

By the insertion of pipes, or the formation of an axial passage in the concrete, wires may be carried from the pole tops to the ground, and thence in any desired direction, and are thus entirely protected at little additional cost.

In damp climates, or in localities where wooden poles are subject to attack by fungi, or insects, concrete poles have a longer life than either steel or timber.

On long or important transmission lines where reliability of service is of great value, it may be conceded that the additional expense of a material superior to timber will often be warranted.

Owing to the natural taper of the timber, it is frequently the case that the weakest section of a timber pole is at some point above the ground level. Therefore there is an excess of material in the butt, which may be considered wasted, except in so far as this surplus timber is useful in resisting decay. A reinforced concrete pole may be given any desired taper and need have no excess of improperly placed material.

The character of service required of line poles is not that of a column, as might at first be supposed, but of a cantilever beam. Further, in order to reduce the stresses in the pole under certain conditions of loading, it becomes necessary for the pole to deflect in the direction of the line, and therefore a certain elasticity is desirable in the material.

If we may judge by the kind of handling which concrete poles successfully withstand, it would seem entirely probable that concrete poles will survive any shocks incident to ordinary service. When subjected to an overload or accidental shock, a timber pole will bend and in some cases survive; but failure, when it does occur, is usually complete, and the pole falls. Concrete poles, on the contrary, while without the elasticity of timber, do not fail by breaking off, but are held by the reinforcement from falling to the ground. Tests also show that a reasonable amount of bending (sufficient for the balancing of stresses in the wires) can occur without apparent injury to the pole.

The chief cause of skepticism heretofore has been the fear that such long, slender members would not be able to withstand, without cracking, the bending stresses and measurable deflections of a pole line. If the poles are properly designed, cracks due to partial failure will not occur. Hair cracks are of infrequent occurrence, microscopic in character, and experience has shown that they will not admit moisture in sufficient quantity to injure a reinforced concrete structure.

In view of the various successful installations in this country and in Europe, and assuming that proper unit stresses are used in designing, and the necessary care taken to obtain a dense mixture and a good surface finish, the writers do not believe that there need be any apprehension of injury due to cracks.

The location of pole lines is not always well adapted to the convenient transportation of materials, and, as the erection of such lines is frequently done by hand or with light rigging, it is not desirable that poles should be of great weight. The greater weight of concrete poles, rendering

their shipment a matter of increased expense, as compared with timber, and the possibility of injury in handling to the site, introduces a question as to the relative advantage of manufacture at the site or at distant yards. In many cases it will be found advantageous to manufacture poles at one or more favorably located points in order to avoid the transportation of raw materials, forms, housing, men, water, etc., and because it is not always possible to obtain space for manufacture immediately adjacent to the site. On the other hand, certain conditions of inaccessibility will make it desirable to haul raw materials to the site, rather than to attempt the more difficult handling of long monolithic poles.

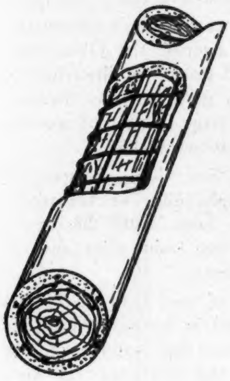


Fig. 2.

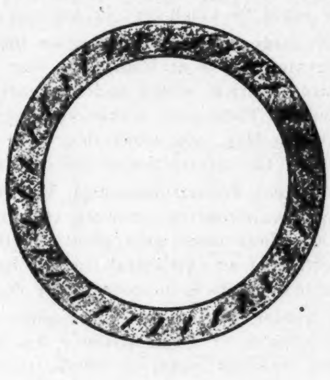


Fig. 3.

The investigation reduces to the availability of the material for the service required and the relative cost. The matter of cost is complicated by the locality of manufacture and the cost of erection, so that at the present time each installation must be judged separately, and the real question at issue is one of availability. It may be noted in passing that, in a number of instances, reinforced concrete poles have been installed at a lower cost than steel or wood.

**History of the Development of Concrete Poles.**

The earliest concrete poles in America were designed and erected on the Isthmus of Panama by Col. G. M. Totten, chief engineer of the Panama Railroad Company, about 1856. Concrete was used on account of the ravages of insects. These poles were about 12 ft. long, circular in section, having a 6 to 8-in. top and 12 to 15-in. base. The wires were carried on iron bracket cross-arms, fastened to the tops of the poles by wrought-iron bands. The proportions of the concrete are not now obtainable. The first poles were entirely of concrete, but since they were not capable of withstanding lateral strains, they were replaced by poles reinforced with a 3 by 3-in. wooden core. This latter construction was also a failure, because the wooden cores swelled and cracked the concrete, and both types of poles were abandoned, so that, in 1888, there were only about twenty of the original installation standing.

About 1900 the practice of using concrete bases around the decayed butts of wooden poles became quite common. It is alleged that these poles are better than new ones, and that a saving of 35 to 55 per cent is made by their use in reconstruction.

The first use of reinforced concrete poles in Europe is perhaps uncertain, but a French engineer, M. Hennebique, was probably the originator of this form of construction. The trolley poles built by him in 1896, for the Le Mans Tramway Company, in France, are in use today. These poles are solid, circular in section, and reinforced with small round rods and transverse wires.

In 1900 M. Porcheddu designed and tested a pole which was about 35 ft. in length, square in cross section, 7 ins. at the top, and 15 ins. at the bottom, solid, and reinforced with small smooth rods. A pull of 4,000 pounds at the top gave a maximum deflection of 2 ft. 6 ins., the pole returning to within 3 ins. of the normal position. This pole safely withstood 4,500 lbs. and broke at 4,700 lbs., but was held by its reinforcement from falling to the ground.

On a high-tension transmission line between Livet and Grenoble, a distance of about 20 miles, M. A. Burgeat installed the combination poles shown in Fig. 2. In the manufacture of these poles wooden poles were thoroughly dried, cleaned and trimmed, reducing the diameter about 1 in. in every 7 ft. In a stiff cement paste covering this wooden core, 3-16-in. round rods were wound in a spiral. Tied to this spiral and placed longitudinally were round rods of 1-16 to 1-8-in. diameter, the cross-section, number, and area of the rods depending upon the length and strength of the poles desired. The concrete covering was applied by placing the seel-encased wooden core in a form and pouring concrete around it. These poles, while strong, were cumbersome, almost as heavy as solid concrete, and required considerable time to manufacture. In addition, a wooden core is subject to organic change, and may cause cracks in the concrete, by expansion or contraction, as its moisture content varies.

A more recent process invented by the German firm of Otto & Schlosser, at Meissen, on the Elbe, consists in manufacturing poles in revolving forms by centrifugal force. A few of these poles have been installed on the government telegraph lines in Meissen, and it is stated that thus far they have not required any maintenance expenditures. To a wet mixture of rich concrete is added finely ground asbestos fiber, and the resulting mixture is placed in a tubular form, inside which the reinforcement of expanded metal has been fastened, and revolved at high speed. It is claimed that the centrifugal action forces the concrete to an even thickness against the reinforcement, the operation taking place in a warm room and occupying but a few minutes. By the addition of asbestos fiber the strength of the poles in tension is said to be increased.* These hollow poles, shown in cross-section (Fig. 3), have the butts filled with stones to the ground-line.

The Bresica Construction Company, of Bresica, Italy, have constructed a novel kind of pole, in lengths from 26 to 33 ft., and of ordinary telegraph, telephone or trolley capacity. The form of construction is shown in Fig. 4; a large round bar in each of the three corners, firmly cross-tied, composes the reinforcement. The poles are cast in wooden

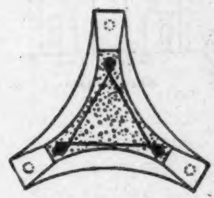


Fig. 4.

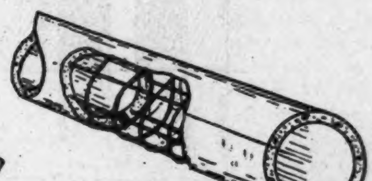


Fig. 5. Siegwart Pole.

forms and are tapered. The manufacturers of this pole claim that their product is cheaper than corresponding iron poles. These poles are unclimbable without a special attachment, which is supplied to the workmen.

Perhaps the most remarkable process of foreign pole manufacture, known as the Swiss process, is that invented and controlled by the Messrs. Siegwart. This embodies a new idea in pole manufacture, and is a strong indication that an economical concrete pole will eventually be evolved to successfully compete, in point of first cost, with the common forms in wood and iron. The Siegwart process consists essentially of a horizontal, collapsible core of sheet

iron, with pivoted ends, carried by a movable frame which is provided with trucks. Below this revolving core is a frame supporting the continuous conveyor belt, which receives, distributes and applies the concrete to the fabricated steel skeleton, when the latter has been fastened in the revolving core. The reinforcement consists of small rods arranged lengthwise and held accurately in place by adjustable rings, with grooves to keep the steel evenly spaced and at the proper distance from the interior and exterior concrete surfaces. On the under frame is mounted an electric motor which operates the moving parts by means of belts and worm gearing. The conveyor belt of heavy wire netting is flat, and by a system of weights is kept constantly taut, so that during a complete forward revolution of the core the concrete is applied or wrapped spirally around the core under pressure, one lap at a time, after which another batch is

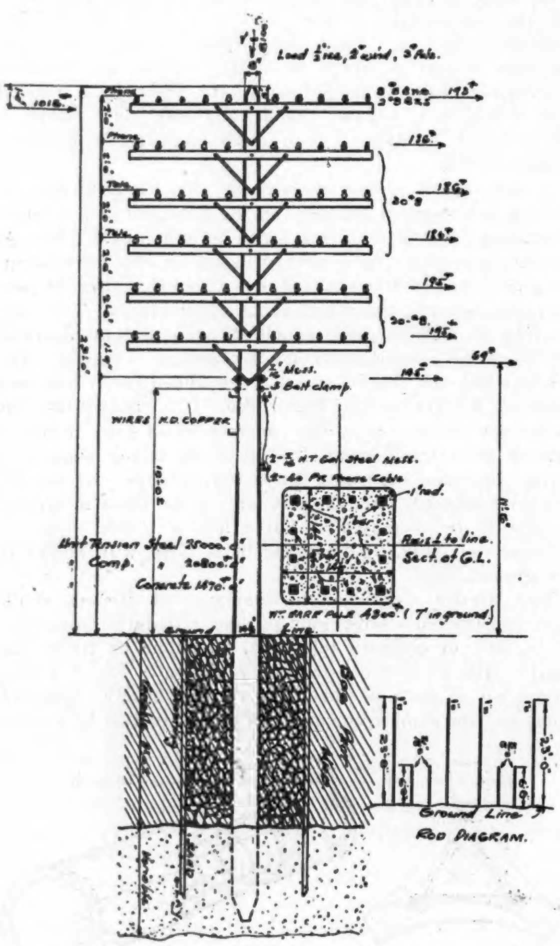



Fig. 6. Reinforced Concrete Pole.

fed upon the belt and the core automatically moves forward. The under frame also carries a small mixer which supplies the concrete simultaneously with the other movements. The concrete is of a dry consistency of Portland cement, sand, and screenings, and as rapidly as applied is bound fast by canvas, wound around and smoothed out by pressing rollers which take up the slack in the canvas binding by a special contrivance. When the core has traveled the full length of the pole, it is entirely covered with concrete and canvas. The pole is allowed to cure in a horizontal position, from ten to fifteen hours, after which the steel core is collapsed and withdrawn. In about seven days, when the concrete has sufficiently hardened, its canvas cover is removed and the pole is ready for the cross-arms and cap. Poles of different lengths, thickness of shell, arrangement and weight of reinforcement, can be made according to the strength required. This system has produced poles up to 45 ft. in length, consuming about an hour in the operation. The poles cost a little more than wooden poles, but less than iron ones, and their light weight facilitates handling and reduces freight charges. They present a good appearance, with perfectly straight lines, and are tapered or fitted with artistic bases to conform aesthetically with their surroundings. The great advantage of these poles is that they can be made by machinery in any size and quantity.

A large number were used on the transmission line of the elevated works at Rathausen near Luzerne, the Olten-Aarburg electrical works, and the central station of the town of Zurich. These poles withstood a heavy snow storm in Switzerland, in May, 1908, which destroyed a large number of wooden poles. The construction of this pole is shown in Fig. 5.

In 1903 Robert Cummings, M. Am. Soc. C. E., constructed some experimental concrete telegraph poles at Hampton, Va. These poles were about 30 ft. long, with the cross-section of an equilateral triangle having 12-in. sides and reinforced with ¾-in. rods in the corners.

Hunter McDonald, chief engineer of the Nashville, Chattanooga & St. Louis Railway, has had in use for some four and one-half years a reinforced concrete support for a standard bridge warning. Some of the first supports were molded complete with pole, brace and cross-arm of concrete. The arm and brace were found to be too expensive, so these parts were afterward made of pipe. One of the poles, with concrete arms and braces, after four and one-half years' service, shows considerable bending, but the composite pole remains erect. For the shaft 1-3 cubic yard of platform screenings, ¼ cubic yard of sand, and 2½ bags of Portland cement were used. The base consists of 1½ cubic yards of stone, ¾ cubic yard sand, and 6 bags of cement.

In August, 1904, two reinforced concrete poles were made for the Schenectady Railway Company, Schenectady, N. Y.

Length ..............................=35 ft.
Cross-section at base..................=14" x 14"
Cross-section at ground...............=11¼" x 11¼"
Cross-section at top...................=6" x 6"
1.33% of section.

(Pole No. 1.)

Longitudinal steel in tension..........=1.68% of section

(Pole No. 2.)

Concrete, a wet mixture of 1:1½:3½ Portland cement, sand and crushed limestone.
Age at test ..........................=6 weeks.

The reinforcement of pole No. 1 was composed of twelve ⅜-in. square twisted steel bars, eight of which were arranged in a circle and enclosed in a spiral of ¼-in. twisted steel, with a pitch of 3 to 6 ins. Four of the bars were 28 ft. long, four 20 ft. long, and the four remaining bars, placed in the corners outside the circle, were full length.

Pole No. 2 was like Pole No. 1, except that the full-length bars were ½-in. instead of ⅜-in.

An accessible point on the railway company's line was used as a casting yard. After seasoning, the poles were handled and loaded by a crane car, carried to their location and placed by the crane and an auxiliary gin pole, and are used to support a double-track span construction over a street. Wooden cross-arms, placed in gains, and supported by the usual metal brackets, are used. In handling, these

*The writers question whether much benefit can be derived by the addition of asbestos fiber, and in view of the experiments by L. S. Moisseiff (Am. Soc. Test. Mat., 1909), would prefer wire scrap.

poles were heavy and cumbersome, several cracks appearing, due to the large taper and the excessive deflection. The reinforcement was not adequate to withstand the strains due to lifting into position. These poles have been in place five years and appear to be in as good condition as when first installed, no signs of disintegration appearing about the cracks just mentioned.

In the early part of 1906, J. B. McKim, superintendent of the western division of the Pennsylvania Lines West of Pittsburg, built a line of 53 reinforced concrete telegraph poles near Maples, Indiana, along the Pittsburg, Fort Wayne & Chicago Railway. These poles vary in height from 20 to 28 ft., the length of pole above ground varying with the profile, so that the telegraph line is parallel to and at a constant distance above the track. The poles are quite small

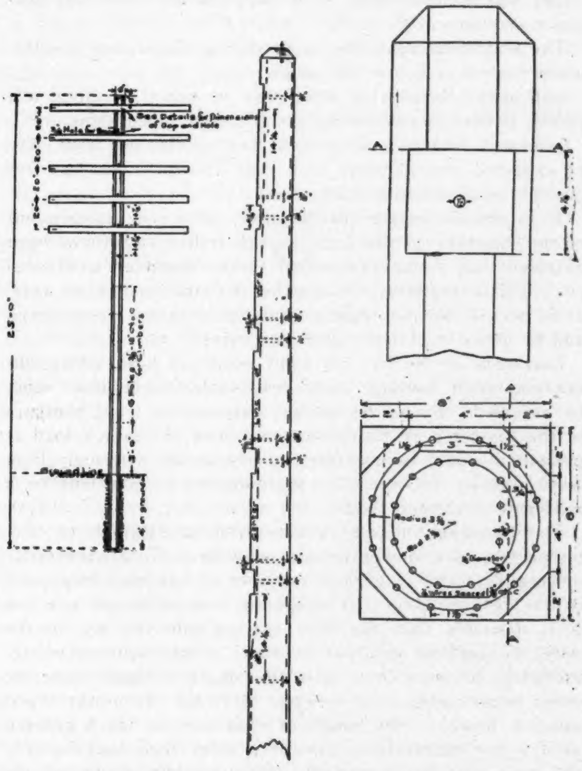


Fig. 7. Details of Reenforced Concrete Poles used by P. F. W. & C. Ry.

in cross-section, and are of minimum weight. They have now been in use four years and show no signs of deterioration. (Fig. 7.)

At the present time several hundred concrete poles are used by the various transmission companies, in distributing to interior points the current generated by Canadian waterpowers.

In 1903 the Concrete Pole Company, of St. Catherines, Ontario, built about twenty poles for the Niagara Falls Power Company, on their main line to Buffalo. A little later a number of transmission poles were built for the Canadian Niagara Power Company, at Chippewa, and for the Ontario Power Company, at Port Robinson and Welland.

In 1906 the same company constructed a power line, for a distance of 12 miles, for the Hamilton Power, Light and Traction Company. The poles are 35, 40, 45 and 60 feet in total length, the longer poles being used at road and other crossings. They are spaced about 200 feet apart and carry 00 B. & S. gauge copper wires, forming two 3-phase circuits of 40,000 volts. These poles sustained safely a test pull of 2,000 pounds applied at the top of the pole. As a part of this work two towers 150 feet in height—believed to be the highest concrete monoliths in existence—were successfully constructed on each side of the old Welland Canal, to carry a transmission line to St. Catherines, Ont. These towers are guyed, but without guys can safely withstand a pull at the top of 2,000 pounds. They are embedded 8 feet in a heavy concrete base, measure 11 inches square at the top and 31 inches square at the bottom, and carry sixteen No. 1 bare copper wires on glass insulators. The cross-arms are of concrete, 3¼ inches by 4 inches by 10 feet long. A platform 10 feet long by 5 feet wide, at a convenient distance beneath, enables workmen to make inspection and adjustments with safety. The canal span is only 76 feet, but the approach span is about 300 feet. One of the towers, in addition to carrying a heavy weight of wires arranged vertically on two frames, is at a right-angled bend and sustains a heavy angular pull.

In 1906 A. C. Chenoweth, of Brooklyn, N. Y., constructed some concrete poles 60 feet long with a base 14 inches in diameter, designed to carry a direct pull of 16,000 pounds and the torsional effect of an arm 4 feet long carrying 8,000 pounds. These poles carried a 500-foot span of 4-inch direct-current transmission cable, and cost about $2.50 per lineal foot.

The Chenoweth concrete pole is rolled by a specially designed machine, and may be made hollow and with a taper. It is formed by rolling steel wire mesh and longitudinal rods, covered with concrete, into a coil.

Reinforced concrete towers of rather huge proportions were erected in 1906 for the West Penn Railway Company for their transmission line crossing over the Monongahela river at Brownsville, Pa. One structure is 150 feet in height, supporting a cable span of 1,014 feet, at an average height of 105 feet from the base of the tower. The tower itself is guyed to an anchor tower in the rear. The larger main tower has a foundation 30 feet square and is 8 feet 6 inches square at the top of the foundation. These immense poles are square, hollow in cross-section, and tapering. Small I beams constitute the reinforcement of the tower, while the base is composed of a large slab, reinforced by a meshwork of rods.

The American Concrete Pole Company, of Richmond, Ind., have constructed for the local traction company, the Terre Haute, Indianapolis & Eastern Traction Company, some forty-three reinforced concrete poles, varying from 14 to 60 feet in height. For poles under 35 feet in height this company claims that it is economical to mold the poles on the ground and erect by derrick. Poles exceeding 35 feet in height are cast in their vertical positions, so that when the forms are removed the pole is ready for service. The forms are constructed of wood and iron so put together as to prevent warping and give a smooth exterior surface. One side of the form is removable to aid in placing firmly and accurately the four longitudinal reinforcing rods. A continuous spiral of binding wire extending from top to bottom forms the web reinforcement.

In this locality it is claimed that a 45-foot pole ready for use costs $25, while in the same locality a dressed cedar pole in position costs $22.50. Under local conditions this company makes the following comparative estimate of the cost of work actually done in the construction of trolley poles.

**Design of Concrete Poles.**

Before entering upon any detailed discussion of design, it is necessary to consider briefly the forces acting upon a pole line and the character of service required of its component parts. As already stated, the function of the pole is that of

a cantilever beam, rather than a column. The external forces are due to dead, ice, and wind loads, which, with the exception of the pressure of the pole, must be transmitted to the pole by the wires. The weight of the wires with their coating of sleet, together with the weight of cross arms, insulators, and the pole itself, is a vertical load which the pole carries as a column. The pressure of the wind on the wires, whose effective diameter is increased by sleet, and upon the pole structure, is assumed as acting horizontally and at right angles to the line. The above vertical and horizontal forces act together on the pole, but since the horizontal forces are applied at the wires, and therefore near the top of the pole, their effect is much greater than that of the vertical forces. In the case of a bend in the line there must be added to the foregoing the horizontal component of the tension in the wires, i. e., the maximum tension multiplied by twice the sine of one-half the angle of the bend.

Again, in case the sags in adjoining spans are not so adjusted as to balance the tension of the wires either side of the pole, there will be an unbalanced pull in the direction of the line, which must be considered in conjunction with the vertical and horizontal forces first mentioned. Unbalanced tension may also be produced by unequal ice and wind loads in adjoining spans.

CONCRETE POLES.

| Length. | Top. | Bottom. | Steel. | Cu. Ft Concrete. | Cost Steel. | Cost Concrete. | Cost Bail Wire. | Labor. | Total Cost. |
|---|---|---|---|---|---|---|---|---|---|
| Feet. | Inches. | Inches. | Inches. | | | | | | |
| 25 | 6 | 10 | 3/8 | 16 | $1 57 | $2.24 | $1.20 | $4.70 | $9 71 |
| 30 | 6 | 11 | 1/2 | 21 | 2.29 | 2.94 | 1.20 | 5.20 | 11.63 |
| 35 | 6 | 12 | 5/8 | 26 | 3.91 | 3.64 | 1.20 | 5.70 | 14.45 |
| 40 | 7 | 15 | 3/4 | 36 | 6.31 | 5.04 | 1.50 | 7.20 | 20.05 |
| 45 | 7 | 16 | 7/8 | 43 | 8.56 | 6.02 | 1.50 | 8.70 | 24.78 |
| 50 | 7 | 17 | 7/8 | 50 | 9.50 | 7.00 | 1.80 | 10.20 | 29.50 |
| 55 | 7 | 18 | 1 | 56 | 13.34 | 7.84 | 1.80 | 11.95 | 34.95 |
| 60 | 7 | 19 | 1 | 61 | 14.56 | 8.54 | 1.80 | 14 70 | 40.60 |

CEDAR POLES.

| Length. | Top. | F O B | | Labor. | Total Cost |
|---|---|---|---|---|---|
| Feet | Inches. | | | | |
| 25 | 7 | $2.60 | (Dressed, graved, ruffed, bored, hauled, and set.) | $1.50 | $4.10 |
| 30 | 7 | 6.25 | | 2.00 | 8.25 |
| 35 | 7 | 8.75 | | 2 40 | 11.15 |
| 40 | 8 | 12.00 | | 3.50 | 15.00 |
| 45 | 8 | 17.20 | | 5.00 | 22.20 |
| 50 | 8 | 20.20 | | 6.50 | 26.70 |
| 55 | 8 | 24.80 | | 8.50 | 33.30 |
| 60 | 8 | 29.75 | | 10.00 | 39.75 |

**Fig. 8. Comparative Cost of Reinforced Concrete and Wooden Poles.**

If it is further assumed that all, or part, of the wires may be broken by excessive loading, faulty material, or by burning, then the pole must withstand a longitudinal force equal to the tension in the wires in the unbroken span. This condition is fortunately very unusual, and is not generally taken into account on intermediate poles.

The usual attachments for fastening line wires to the insulators do not have sufficient strength to develop the ultimate stress of the wire, and, therefore, a broken wire would pull through into the adjoining spans before exerting its maximum tension upon the poles. As a matter of economy, it is usually better to dead-end the wires and poles at intervals and confine the effects of broken wires to the section in which the break occurs, rather than make every pole and attachment of sufficient strength to dead-end the line.

In addition, it can be shown by a rather complicated mathematical demonstration that, owing to certain properties of the catenary curve, a slight bending in a number of poles will balance the tensions in adjoining spans.

"Omitting from consideration the effects of tornadoes and cyclones, it is necessary to determine, or assume, the maximum velocity of the wind, for general practice, or for any particular locality. . . . The records of the United States Weather Bureau—omitting tornadoes, cyclones, and violent gales occurring in some particularly exposed situations—give a maximum indicated velocity of 100 miles per hour. . . ."

A tabulation, by months, of the highest indicated velocities recorded by the United States Weather Bureau, at the New York City station, from 1884 to 1906, and of the number of different twelve-hour periods, during which a maximum velocity of 60 miles, or more, was observed, from 1895 to 1906, shows that:

The maximum velocity of 80 miles per hour occurred during a sleet-storm.

The maximum velocities occur during the winter months, when sleet may be on the wires.

Indicated velocities of more than 80 miles per hour will rarely, if ever, occur during the life of a given structure.

Indicated velocities of from 65 to 75 miles per hour may be expected several times each year, though much less frequently in conjunction with sleet.

To a certain extent the thickness of ice is independent of the diameter of the wire, though it has sometimes been assumed that a thickness equal to the diameter would occur. This is manifestly wrong for the smaller sizes of wire, as is proved by the coating of twigs in every sleet-storm, and by actual experience with line wires.

Inasmuch as the ice and wind loads are both acting under maximum loading, some reasonable combination must be assumed. Since the surface exposed to wind pressure is the diameter of the ice-covered wire, if no ice load is present it would be necessary to assume an extremely high wind velocity to obtain a maximum load equivalent to a moderate combined load.

The transition in pole capacity from a telegraph or telephone line to a power transmission line is not necessarily discernible; in fact, the load per foot of line may be greater in the former case. In telephone and telegraph practice it is desirable that the wire spacing and the sag in the wires be kept as small as possible. This requirement immediately places a limit upon the length of span, since the wires require support at frequent intervals. In power transmission, however, the length of span may be much greater, as it is not necessary to place the wires close together and the sags may be increased. Economically speaking, the span should be as great as the proper spacing of wires and the necessary clearance between the wires and the ground will permit. Within limits, an increase in the span length merely adds an inappreciable amount of wire, requires a greater distance between the wires, a slight increase in the pole height, and, sometimes, a better grade of insulator. On the other hand, both the number of insulators and the number of poles is reduced.

While it is common practice to use wire guys, in open country, both normal and parallel to the line, in populated districts the use of guys is necessarily restricted, and in any case constitutes a nuisance and expense in maintenance.

While the combination of a high wind and a large accretion of ice is not entirely unknown, such combinations are not very frequent, occurring perhaps once in a decade. If it is desired to reduce the first cost as much as is compatible with safety, the poles may be designed, using high-unit stresses for conditions that rarely, if ever, occur. In regard to the factors of safety, unit stresses, and working stresses, to be allowed in the constituent materials of a reinforced concrete pole, there is as much room for latitude of judg-

ment as in other structural work. The character of service is not closely akin to that of bridges or buildings, and the factors of safety common to such work would be somewhat conservative, for poles computed for extreme conditions of loading.

The present practice differs rather widely as to the most economical or most desirable distribution of reinforcement. It is now generally conceded, in reinforced concrete work, that the finer the distribution of metal, the greater the homogeneity and strength of the construction. However, in the case of poles, where the concrete is deposited within narrow forms, other conditions partly modify or control the distribution. If the metal is concentrated in four equal areas, a rod to each corner, a square pole will be equally strong, either parallel or normal to the line. Other or finer distribution of metal with equal strength in both directions necessitates an excess of material over that required for the forces normal to the line. When the metal is concentrated, the fabrication of the reinforcement into a unit frame, and also the concreting operations, are more easily accomplished. It may be said, as in the case of beams, that ample web reinforcement assures a firm unyielding unit during concreting, as well as provision against vertical shearing stresses.

In other fields of reinforced concrete work high-carbon steel with a high elastic limit, and a correspondingly richer concrete, are being used, permitting higher working stresses in design. If, in such work, high-unit stresses can be used, with a large percentage for impact, it would seem entirely reasonable to use correspondingly high working stresses in pole design, since the severe conditions of loading occur infrequently.

The most commonly used mixture is 1:2:4 Portland cement, sand and broken stone or gravel. It should be mixed wet, using carefully selected materials, with the fine aggregate next to the forms, and tamped or churned to eliminate air-bubbles. Such a mixture has an average compressive strength of about 900 pounds per square inch in seven days, 2,400 pounds per square inch in one month, 3,100 pounds per square inch in three months, and 4,400 pounds per square inch in six months. If conditions make it desirable to use high working stresses, a month or more should elapse before new poles undergo severe tests.

Since in solid poles of light capacity the loading produces a low compressive unit stress in the concrete, a considerable area of concrete might be omitted, or, theoretically, the economical section would be a hollow one.

The increased weight of a solid pole renders it more difficult to handle, and a hollow pole would therefore be more economical in erection. Further, the sides of the pole resisting the bending stress normal to the line might be at a greater distance from the center than the sides perpendicular to the line.

There are, however, certain objections to the use of hollow or unsymmetrical sections. The former are difficult to make properly, and the cost of the forms is greatly in excess of that required for solid sections. The unsymmetrical sections may perhaps be open to criticism on the score of appearance, and if the lack of symmetry is very pronounced, render the poles relatively weak in the direction of the line. Conservative reasoning would dictate that such poles, sometimes styled "whip lash" construction, should be interspersed with "dead-end" poles of heavier design.

In general, a square, octagonal, circular or other cross-section may be used, but it is desirable as a matter of appearance, since sharp corners are difficult to make and subject to accident, that all such corners be chamfered or rounded. The minimum diameter, or width, at the top may be made 6 inches for small poles, and increased as required for the strength and appearance of long poles or poles carrying a heavy line. In any case care should be exercised, in determining the taper and reinforcement, that no weak section occurs at some distance above the ground-level.

### RAILWAY STRUCTURES.

The Atlantic Coast Line, it is said, will build a new freight house at Troy, Ala.

A contract has been given to Phelan & Shirley for grading the approach to the Canadian Pacific high level bridge from the Strathcona side, at Edmonton, Alb. The contract calls for the removal of about 58,000 cu. yds. of earth.

The Western Maryland will construct a double track steel bridge across the Potomac river at Cumberland, Md.

Work on two additional roundhouses at the Cleveland, Cincinnati, Chicago & St. Louis shops at Beech Grove, Ind., is to be started this week. After all the improvements at Beech Grove are finished there will be 90 tracks between the shops and the main tracks.

The Dominion railway board has decided that a bridge is to be built at the junction of King and Queen streets in Sunnyside, Toronto, Ont., to abolish the present grade crossing. The cost of the improvement will be about $175,000.

The Baltimore & Ohio has accepted plans for the elimination of its Ludlow avenue crossing at Cincinnati, O. By the terms of the agreement the railroad is to pay 65 per cent of the cost, the city bearing 35 per cent.

The Oregon-Washington Railroad & Navigation Co., the Great Northern and the Northern Pacific have approved plans, it is said, for the construction of a passenger station, freight sheds, repair shops and a roundhouse at Centralia, Wash.

The Harriman Lines have released specifications for 12,000 tons of bridge work to the American Bridge Co.

The Chesapeake & Ohio will electrify its line from Newport to Melbourne, Ky. At the latter place large repair shops are now nearly completed. A large freight depot will also be built in Newport

The Chicago, Burlington & Quincy is asking bids on a passenger station of brick construction, with tile floors, slate roof, hot water heat and hardwood finish at Centerville, Ia. The estimated cost is $25,000.

The Atlantic Coast Line has ordered 200 tons of material from the Pennsylvania Steel Co., for a lift bridge to be built at Navassa, N. C.

Bids have been received for an overhead bridge at Lethbridge, Alb., for the Canadian Pacific. There will be a 350-ft. steel span, two 60-ft. steel girders and a 450-ft. timber approach.

The Chicago, Rock Island & Pacific is about to open bids for the construction of an in-and-out-bound freight station at Little Rock, Ark., to cost approximately $100,000.

The Atlantic City R. R., Camden, N. J., is receiving bids for the erection of an engine house to be built at Camden. It is to be a one story brick structure, 160 by 65 ft. in size.

The Canadian Pacific will let contracts in a short time for the erection of water tanks at Port Arthur, Ont., to operate by gravity, the water supply to be drawn from the small lakes in the vicinity.

The Atchison, Topeka & Santa Fe will build a passenger station at Sweetwater, Tex., to cost about $25,000.

The Erie R. R. will expend about $60,000 in enlarging its repair shops at Hornell, N. Y.

The Lake Shore & Michigan Southern is planning to erect a freight station costing about $100,000 at Kalamazoo, Mich.

The Louisville & Nashville has let contracts to the American Bridge Co. for furnishing the superstructures, and to the Foster-Creighton-Gould Co., Nashville, Tenn., for erecting in the reconstruction of the bridges over the Choctawhatchee and Apalachicola rivers, on the Pensacola division.

The Illinois Central has had plans prepared for a $200,000 depot to be erected at Waterloo, Minn.

The Canadian Pacific and the Canadian Northern will build a union station 316 ft. by 62 ft. at Regina, Can. The main building will be three stories high, and there will be a one story annex on either side.

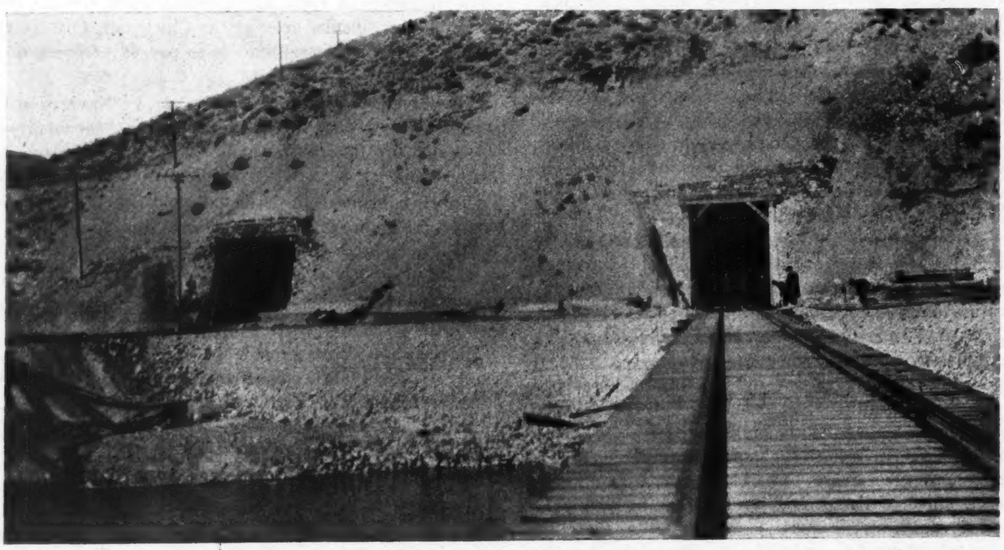
The Macon, Dublin Savannah will expend from $225,000 to $250,000 on terminal facilities at Macon, Ga. The improvements will include a freight yard and depot, an office building, a brick warehouse, loading platforms, a steel bridge with draw span, and about two miles of new trackage.

The Grand Trunk will build new steel coal chutes, with a bunker capacity of 350 tons, to cost about $15,000, at Ottawa, Ont.

The Western Pacific has given a contract to Hyde, Hayes & Co., San Francisco, it is said, for a new 215-ft. dock at Sacramento, Cal.

## DISADVANTAGEOUS LOCATION FOR A RAILWAY CROSSING.

A more disadvantageous crossing than the one shown in the accompanying illustration would be hard to imagine. The Eureka & Palisades Ry. is the one running along the side of the hill, on the bank of the Humboldt river, and crossing the Southern Pacific and the Western Pacific Rys. at right angles. Each of the last two railways pierces the hill in a single track tunnel, the crossing shown being just at the portals. There is frequently difficulty in operating trains through tunnels, and stopping a train in one is practically prohibitive on account of the gas and fumes coming from the engine, unless the ventilation is exceptionally good.



A Disadvantageous Location for a Railway Crossing.

Before proceeding into the tunnel it is necessary, therefore, that a train should have right of way over the crossing. The tunnel on the Southern Pacific is 880 feet long, which is somewhat over the usual maximum for an interlocking home signal. The location of this signal would probably have to be at a point a half mile or so before reaching the portal of the tunnel, in order that a heavy freight train could get up speed before entering the tunnel. The operation of this crossing was to have been by means of an interlocking plant, for which the plans have already been made.

A considerable portion of the Eureka & Palisades Ry. (which is 88 miles long) was recently washed out, and operation has not been resumed; consequently the construction of the interlocking plant has been temporarily abandoned.

## IMPROVEMENTS ON THE PERE MARQUETTE.

Considerable interest is being displayed in railroad circles by the movement of J. P. Morgan & Co. in the rejuvenation of the Pere Marquette system. Since Morgan & Co. acquired control of the Pere Marquette from the Cincinnati, Hamilton & Dayton it is said that the Pere Marquette is enjoying the distinction of having the highest operating cost of any large system in the United States.

In February it took 97½ per cent of the gross earnings to operate the road, while in March the operating ratio was 83½ per cent. This increased cost of operating is due to the fact that the new owners are spending a very large amount of money in rebuilding a greater part of the road and making improvements along the line and also in purchasing new rolling stock and operating material.

Only recently the Pere Marquette purchased fifty of the larger type of locomotives and several hundred freight cars, as well as a number of passenger cars. Walter Cotter, president of the road, stated at a meeting of the directors held in New York that the plans for extension recently outlined by the management had been accepted and were well under way and that the outlook for the coming year was extremely bright.

Prior to J. P. Morgan & Co. acquiring control of the Pere Marquette the road was in a run-down condition and some of the rolling stock was very poor. All of these defects are being remedied very rapidly and it is thought by the end of 1911 the road will be in an unusually good condition. A great deal of new equipment is in operation at the present time and hundreds of tons of heavier rail have been laid.

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The Chicago & Lake Superior Ry. has for sale 250 tons of good relaying 60 pound steel, also angle bars.

The Isthmian Canal Commission is receiving bids on rails up to July 18, particulars of which are given in circular 635.

It is reported that the Northern Pacific is in the market for 50,000 tons of rails.

Rails to a total of 23,050 tons have been ordered by the Baltimore and Ohio, of which the United States Steel Corporation is to roll 13,050 tons, 8,050 at the plant of the Illinois Steel Company and 5,000 at the Carnegie mills. The Cambria Steel Company is to furnish 7,500 tons and the Bethlehem Steel Company 2,500 tons.

# The Signal Department.

## RAILWAY SIGNAL STANDARDS—NO. 18—THE CHICAGO GREAT WESTERN R. R.

The Chicago Great Western is using three position upper quadrant signals, as shown in Fig. 404, on new installations. Their older signals are two position lower quadrant. Low signals are located on brackets on high signal poles, where the latter are convenient. The two position signals operate through an arc of 60°, and the three position signals operate from 0° to 45° to 90°. Signals are normally clear, and the color indications are green for clear, yellow for caution, and red for stop. Signals are semaphore type, operated by direct current electric motor, the mechanism being at the bottom of the pole in the signal mechanism case shown in Fig. 405. The numbers on the signal poles (Fig. 404) indicate the number of miles from Chicago. East-bound signals show miles to the nearest even tenth, west-bound to the nearest odd tenth. Figures are black on a white background facing against the direction of traffic. Battery wells are made of concrete, and battery chutes are of either concrete or iron.

From St. Paul to South St. Paul, a section five miles long, signals are operated by portable storage battery. The cells are charged at the charging station and delivered direct by

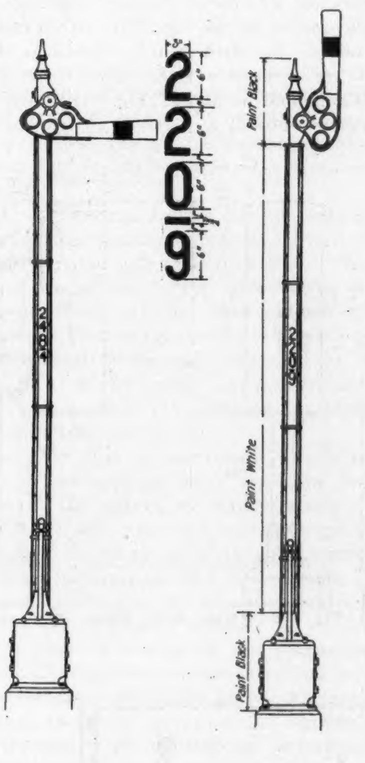


Fig. 404. Three Position Upper Quadrant Signal, Chicago Great Western.

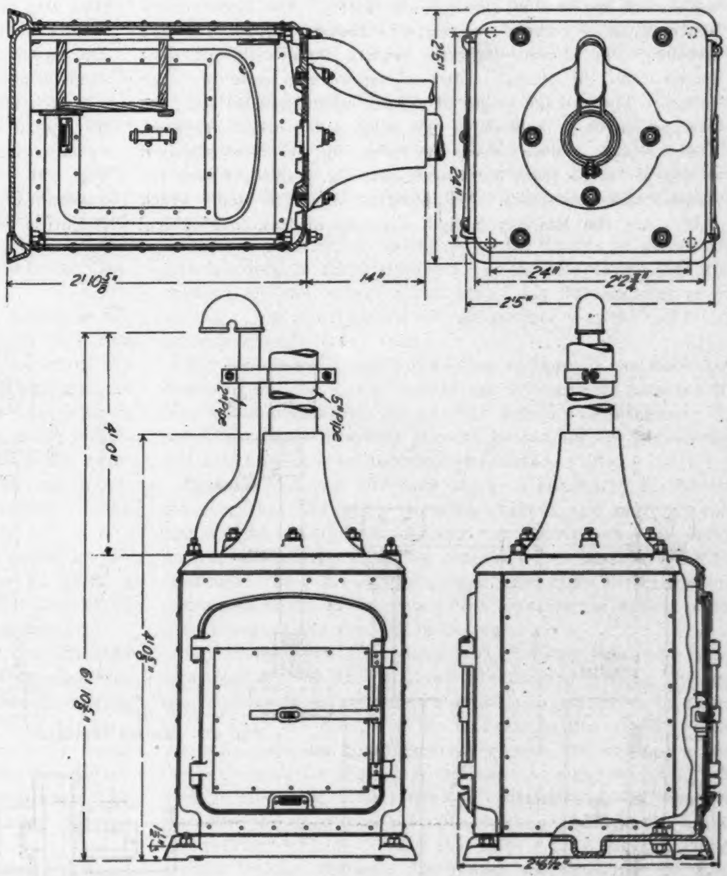


Fig. 405. Signal Mechanism Case, Chicago Great Western.

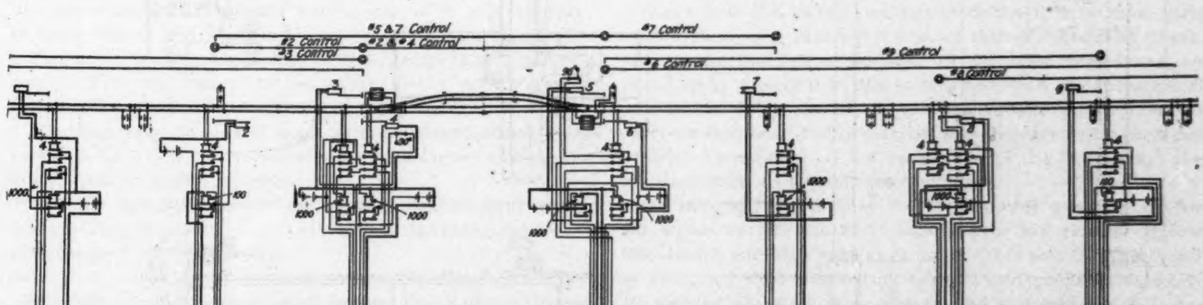


Fig. 406. Standard Wiring for Single Track Automatics, Chicago Great Western.

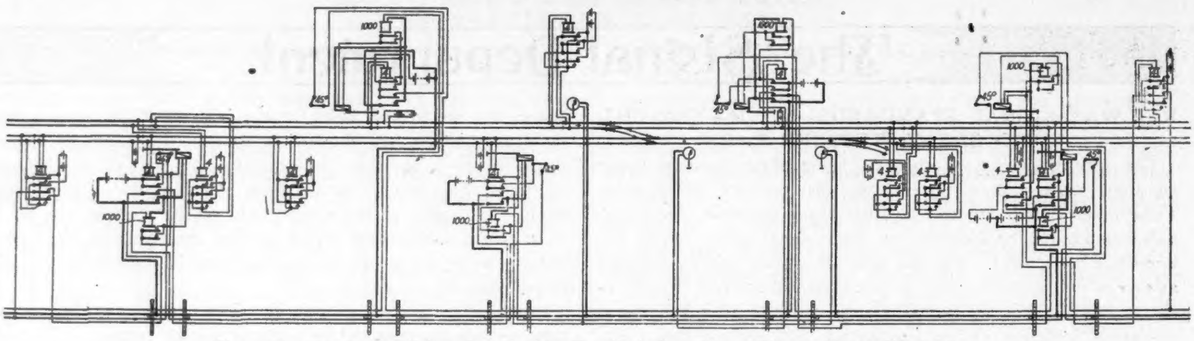

Fig. 407. Standard Wiring for Double Track Automatics, Chicago Great Western.

motor car. On the Eastern Division, which is 261 miles long, signals are operated by caustic soda battery. The same battery which supplies current for signals supplies current for line circuits. The gravity batteries require three cells for each section, and the storage batteries require two cells for each section. The average length of a track circuit is 3,000 feet; the average length of a block is two miles and overlaps are used. Common wire is broken every five miles. Fig. 406 shows standard wiring for single track automatics, and Fig. 7 shows wiring for double track automatics. No automatic stops are used. Track relays are the Railway Signal Association standard neutral type, of 4 ohms resistance, as shown in Fig. 408. Standard relay box mounted on a junction post is shown in Fig. 409.

Wire ducts are below ground and made of wood. No pole line signal circuits are carried on separate pole line. The wire used on pole lines is No. 10 copper clad steel.

Switch indicators are used on all switches where the view of the signal is obscured or if the signal is not located in the vicinity of the switch. Standard switch indicator is shown in Fig. 410. They are semaphore type, either upper or lower quadrant, not illuminated at night. Fig. 411 shows the installation and connections of a standard switch box.

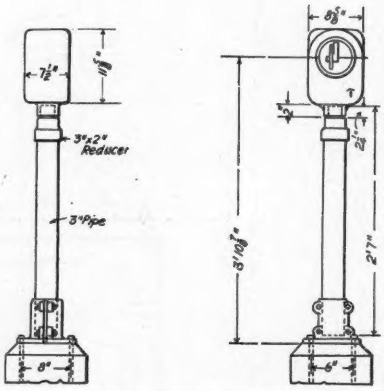

Fig. 410. Switch Indicator.

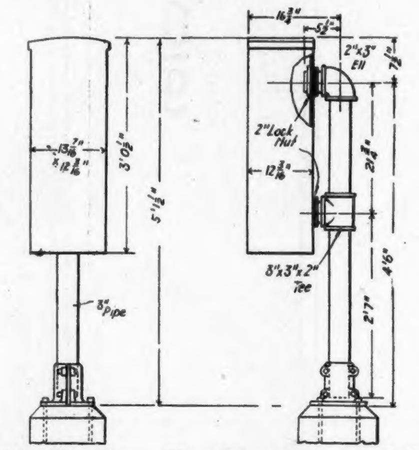

Fig 408. Three Way Relay Box and Post.

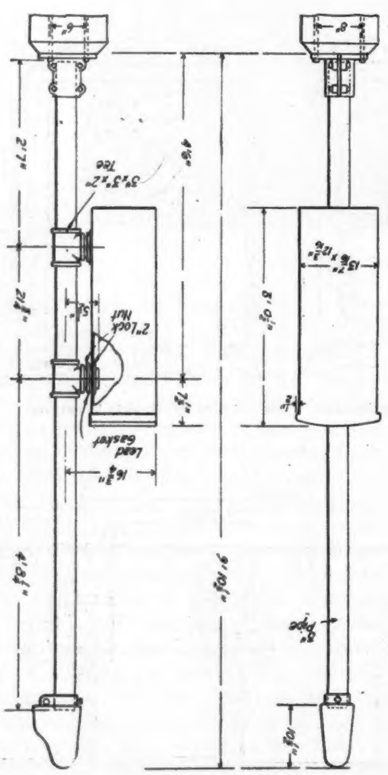

Fig. 409. Junction Post with Relay Box.

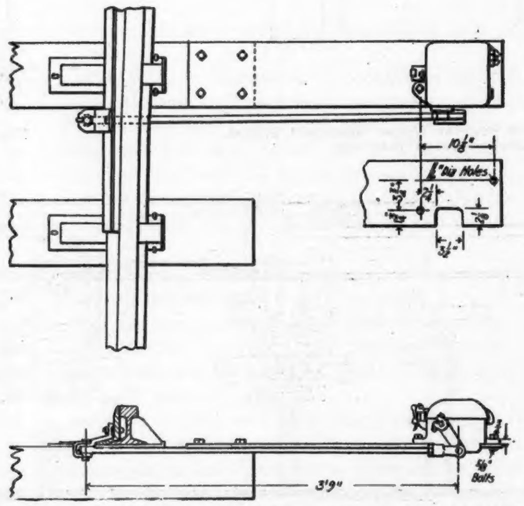

Fig. 411. Switch Box Installation, Chicago Great Western.

# Selection of Alternating Current Signaling Apparatus*

By L. Frederick Howard.

The object of this paper is to state the principles which call for attention in the selection of alternating current signaling apparatus, and to discuss their bearing on the system embodying such apparatus. Both electric and steam road conditions are considered.

### Inductive Bonds.

From the point of view of the signal engineer the inductive bond constitutes a leak from rail to rail for the alternating signaling current, the same as do the ballast and ties.

It will be seen, however, that, while the leak through the ballast is distributed, that through the bonds is concentrated at the ends of the track circuit, being the greatest of course through the bond nearest the transformer where the voltage is highest.

Furthermore, since the bonds constitute an inductive leak, while the ballast and ties constitute an ohmic leak, the actual sum of the two kinds of leakage is less than the arithmetical sum.

The leakage through the ballast increases with wet weather. The leakage through the bonds increases when for any reason unequal amounts of propulsion current above a certain value flow through the two halves of the bond winding When this inequality exists the bond is said to be "un balanced."

The unbalancing current is the difference between the values of the populsion current carried by each rail, and flowing in either half of the winding. The iron core of the bond is magnetized by this unbalancing current as well as by the signaling current. The measure of the magnetizing force of the propulsion current in ampere turns is the unbalancing current in amperes multiplied by one-half the number of turns in the bond. Under ideal conditions no unbalancing exists, each rail carrying an equal portion of the total propulsion current.

Now when iron is magnetized to a certain point, an increase in magnetizing force does not produce as great a change in the degree of magnetization of the iron as it would if the iron were not magnetized to that point.

Hence it comes about when unbalancing occurs, that the iron core being magnetized to a certain point by the "unbalancing" portion of the propulsion current, the alternating signaling curent passing through the windings does not produce as great a change in the magnetization as if equal amounts of propulsion current were flowing in the two halves of the winding, which would be the ideal condition. The reactance therefore decreases and more alternating current leaks through as the unbalancing increases.

To decrease the variability of the leakage through the bond with variation in the unbalancing, there is introduced in the magnetic circuit of the bond an element which, while it will not allow as much magnetic flux to pass with a given magnetizing force, will always, when considered by itself, give a change in flux corresponding to the change in magnetizing force. This element is air; in other words, an air gap is provided in the magnetic circuit of the bond.

The iron may be looked upon as the element which gives to the bond a low but variable value of leakage, making the bond sensitive to unbalancing.

The air gap may be looked upon as the element which gives a high but more constant value of leakage, and lesser sensitiveness to unbalancing.

*Extracts from a paper read before the Railway Signal Association.

The point at which the leak through the bond increases is not necessarily of course the failing point of the track circuit, for this depends also on the factor of safety allowed in the supply of energy to the track circuit.

That is to say, so far as the signal engineer is concerned, he can avoid signal failures due to unbalancing by using a bond with no gap, or a small one, and using a sufficiently high voltage on the track circuit to take care of the variations due to unbalancing, or by using a large air gap and taking more current initially. In both cases, however, the provision for unbalancing means an expenditure of energy, but with the advantage in favor of the bond with the air gap, because of the increased stability of the track circuit and consequent reduction of voltage variations across the terminals of the relay.

As stated before, the magnetizing force due to the unbalanced propulsion current may be expressed in ampere turns. Therefore, if an unbalancing of 300 amperes, for example, exists in a bond with eight turns and the tap at the middle, the magnetizing force due to the unbalancing is 1,200 ampere turns.

For the purpose of testing how this degree of magnetization is going to affect the "leak" of the alternating signaling current, we can, where a current of say 300 amperes is not available, use a test coil of a large number of turns and taking correspondingly less current.

We cannot apply our alternating voltage to the same coil, however, for the meters would not differentiate between the two kinds of current, so another winding is necessary for the alternating signaling current preferably of low enough resistance to give no appreciable resistance drop.

But the first coil will now act as a secondary to the coil carrying the alternating signaling current, and an A. C. voltage will be set up in it causing reactions on the coil carrying the alternating signaling current which would vitiate the readings. Two bonds with their test coils are, therefore, connected so as to neutralize this transformer action in the coils carrying the propulsion current.

The desirability of a small leak through the bond is accentuated by the fact that all the current leaking through the bond at the relay end of the track circuit has to be transmitted over the rails, with an increase in the voltage across the rails opposite the transformer over the voltage across the rails opposite the relay, sufficient to compensate for the drop in the rails. The more the current taken by the bond the more the drop over the rails and consequently the higher the average voltage across the rails. This in turn means greater leakage through the ballast, and through the bond opposite the transformer.

But for the same reason that the actual sum of the bond leakage and the ballast leakage currents is less than their arithmetical sum, that is because of their being out of phase, due to the reactive component of the bond impedance, so the drop in voltage over the rails is less than the arithmetical sum of the drops due to the two leakage currents. The two currents will have the greatest phase displacement when the reactive component of the impedance of the band bears the greatest ratio to the ohmic component.

To sum up then, to keep down the power consumption for the signal system the bond should have low resistance, low iron losses and high reactance, or in other words, if the bond is energized with alternating current and properly connected with an ammeter, a voltmeter, and a wattmeter, it is desirable that the quotient obtained by dividing the volts by

the amperes should be as large, and the watts as small, as possible. In this test the voltage should be the same as that to be used in service.

In addition to the reasons already mentioned, there are two others why it is desirable that the ohmic resistance of the bond should be low. Resistance is one of the factors in determining the temperature rise of the bond due to the flow of the propulsion current. It is also a factor in determining the value of the propulsion current voltage to which the relay is subjected when "unbalancing" exists.

Suppose the resistance of the two parts of the bond winding from A to B and A to C to be 0.0002 ohm each and that 2,000 amperes are flowing in each rail. Then as the watts lost by a current flowing in a conductor are equal to the square of the current multiplied by the resistance of the conductor, the watts lost in the bond and connections due to the propulsion current, will $2 \times \frac{2}{1{,}000} \times 0.0002 = 1{,}600$, or a little over two horse-power.

This loss shows itself in the form of heat, and the radiating surface of the bond should be sufficient to keep the temperature rise down to a point below that at which the insulating materials used in the bond begin to deteriorate. As a rule this point is much higher than for most electrical apparatus.

Whether or not the capitalization of the loss would warrant the use of a larger size of copper depends on the cost of the propulsion current.

There is another important result of unbalancing.

Supposing that unbalancing exists to the extent that 2500 amperes are flowing from A to B and 1500 amperes from A to C, then if the resistances from A to B and A to C are each 0.0002 ohm, the voltage drop from A to B is $C \times R$ or $2{,}500 \times 0.0002 = 0.5$ volt. From A to C the drop is $1{,}500 \times 0.0002 = 0.3$ volt.

The difference between these two drops, i. e., 0.2 volt, is the voltage across the rails, due to the unbalanced propulsion current, tending to cause the propulsion current to flow through the windings of the relay or transformer connected to the rails at that point.

It is easily seen from these examples that while resistance in the winding of the inductive bond is objectionable, its effects can be predetermined and allowed for in the design and selection of both the bond itself and the related apparatus. The exact value of the resistance to be used can be decided on when its various effects on cost and operation have been considered.

For the electric railway engineer direct current inductive bonds have at first thought just one point of interest, i. e., circular mils. This is because he always thinks first of the cross sectional area of his rail joint bonds.

What he is really interested in is the resistance introduced by the inductive bond in the return path of the propulsion current, and this resistance depends upon the length of the winding of the bond as well as on its cross section.

Furthermore, the inductive bond may be used only once in a mile of track, while the rail joint bonds occur every rail length, so it is at once apparent that so far as the electric railway engineer is concerned, the winding of the inductive bond may have a much smaller cross section and a much higher resistance than the rail joint bonds, and nevertheless introduce only a small percentage increase in the resistance of the return path of the propulsion on current.

What has been said so far concerning reactance bonds has been said with the bonds in mind which are used on D. C. electric roads. The same principles apply in the case of the bonds for A. C. propulsion roads except in the case of unbalancing.

The trolley voltages used with A. C. propulsion are much higher than with D. C. propulsion, and the propulsion current is correspondingly lower. For instance, where 2,000 amperes per rail were assumed in a previous example, supposing 500 volt D. C. propulsion, for 11,000 volt A. C. propulsion the current would be, say, 100 amperes per rail.

It is at once apparent that the heat generated in the bond by the A. C. propulsion current will be much less than with the D. C. current with a given resistance of winding.

The A. C. propulsion current being small, a given percentage of allowable unbalancing means also a small actual value of unbalanced current to be provided for.

Now, the most common cause of unbalancing, i. e., the introduction of resistance in one side of the rail circuit by poor bonding, is common to both A. C. and D. C. propulsion. The effect of resistance in the two cases is different, however. With the D. C. current, doubling the resistance of one side of the rail circuit would mean that one-half as much propulsion would flow on that side as the other, and we would have 33⅓ per cent unbalancing.

The impedance offered by the rails to the flow of the A. C. propulsion current consists of both resistance and reactance, however, and the resistance component is larger than the resistance offered by the rails to direct current because the alternating current tends to flow through the shell of the rail. Therefore, if we introduce the resistance, say a poorly-bonded joint which caused an unbalancing of thirty per cent with direct current propulsion, the unbalancing will be about eight per cent with the 25 cycle propulsion, neglecting the transformer action of the bond.

The fact that the unbalanced currents to be provided against the A. C. propulsion are so much smaller than with D. C. propulsion, is very fortunate, on account of the transformer action which takes place in the bond when unbalancing occurs.

With equal amounts of current flowing through the two halves of the winding there is no magnetic effect on the core of the bond. With unequal amounts of direct current flowing it was shown that the core became magnetized, and a difference of D. C. potential appeared across the terminals of the bond equal to the value of the unbalanced current in amperes multiplied by the resistance from the middle of the bond to the rail.

With the unbalanced alternating propulsion current the difference of potential appearing across the rails, due to the propulsion current flowing through one-half the winding of the bond would be small, if the resistance only were considered, for we have shown that the amount of the unbalanced current against which it is necessary to provide is small. We have, however, shown that it is very desirable to have a bond of high reactance to keep down the leakage from rail to rail of the signaling current. But the flow of the unbalanced alternating propulsion current is also opposed by the reactance and we have a potential set up between the middle part of the bond and the rail, the value of which is proportional to the frequency and amount of the unbalanced current, and the reactance of the bond.

Moreover, as the magnetic circuit of the bond is common to both halves of the bond winding, the other half of the winding will act like a secondary to the first, and we will get twice the potential across the rails which is developed by the unbalanced propulsion current flowing through one-half of the bond wiring. It is seen, therefore, that when the reactance of a bond for A. C. propulsion is increased to reduce the leak of the signaling current, the selective track relay must be able to take care of a correspondingly higher value of the potential across the rails due to unbalanced propulsion current.

**Track Relays.**

A relay on a steam road may be subjected to the influence of foreign or stray current where it parallels an electric road.

The return current from the electric road passes on to the steam road rails, and back over them by way of ground and pipes to the negative side of the propulsion generator. In so doing it may pass through the steam road relay.

In the same manner a track relay on what has become known as a single rail track circuit of an electric road, may be subjected to the influence of the propulsion current.

Having determined the voltage due to the propulsion current to which the track relay may be subjected in service, this voltage should be applied to the track winding of the relay being considered and the effect on the speed of action of the relay and on its temperature rise noted. The latter should be well below the point causing any binding due to expansion, and below the point at which the insulation would soften on the hottest summer day.

If the relay has two energizing windings the effect should also be tried of short circuiting the terminals of the track winding and setting the moving element in various positions both with the other winding open and with it energized to various degrees with the frequency of alternating current which it is proposed to use.

Where the relay is designed to give protection against broken down insulated joints, the track winding should also be subjected to a voltage differing in phase from that normally supplied, by the smallest amount which could occur in practice. Under these conditions the contacts should of course open. The relation of the pick-up and drop-away voltages should be tested for mechanical reasons.

**Transformers.**

The selection of transformers for signaling purposes should comprise a consideration (in addition to that of cost) of insulation, regulation, and efficiency.

The insulation should be equal to that of the transformers of the best manufacturers. The ground shield is probably desirable for the same reasons as the grounded secondary of the commercial transformer for which it is a substitute. The regulation of a commercial transformer pertains to the change in secondary voltage which takes place between full load and no load. A signal transformer generally has two or more secondaries. Its load generally consists of a constant part and a variable part, the latter being due in most cases to changes in load on track secondary or secondaries due, for instance, to the presence or absence of a train on the track circuit and to the operation of the signal motor.

The voltage variation to which the connected apparatus may be subjected being less, therefore, than that which occurs on going from full load to no load, the signal engineer should from his track circuit plan determine for each secondary the conditions which give the maximum and minimum loads on the transformer coincidentally with the maximum and minimum load on any secondary, and specify the voltage variation allowable on that secondary for those conditions.

As regards efficiency, the customer should know the losses in his transformer in order to determine whether or not their capitalization indicates any change of conditions, either in his system or in the transformer, which would insure an ultimate saving. The losses which occur in the transformer when carrying its prevailing load should of course be the determining factor, and not the losses occurring when the signals are clearing or the track circuit occupied, if this occurs but seldom.

The losses occurring under these latter conditions should be given due weight, however.

When a transformer serves the double function of supplying current and regulating the amount of current under short circuit conditions, the transformer losses should be credited with the losses which would be entailed if some other means of regulating the current were used.

**Signal Motors.**

The choice of the motor for the signal is influenced by very much the same considerations as for other purposes except that the actual efficiency of the motor, i. e., the ratio of watts input to watts output, is a negligible factor in the energy consumption of a signaling system, since the total energy consumed in clearing the signals is relatively negligible. That is to say, if we are considering steam road conditions, where the power taken by the signal motor is, relatively, of the most consequence, the track circuit, slot, lamp, and transformer losses will probably take an amount of power which at three cents a kilowatt hour would cost a trifle over five cents a day, while the cost of power for fifty operations of the signal, even by a single phase induction motor, would not be over 0.04 of a cent, or less than one per cent of the total power.

The apparent efficiency of the motor, i. e., the ratio of apparent watts input to the actual watts output, is of interest in but two ways: First, as affecting the increase of the normal supply of current to the signal system in case it has been interrupted, and it is necessary to clear all signals at once (even here it is seldom of much importance if the transformers on the system have been provided with taps for taking care of normal line drop). Second, as affecting feasibility of distant signal control without the use of line relays.

As regards commutator motors versus induction motors, the balance as regards reliability and ease of maintenance will probably, as in the industrial field, work out in favor of the induction motor. With the single phase induction motor, increased economy gained by phase splitting devices involving contacts should only be chosen after a full consideration of the degree of reliability likely to be sacrificed.

For signals having a low ratio of gearing, the commutator motor becomes almost a necessity on account of the high torque which it is necessary to develop, the current consumption of the induction motor being, comparatively, almost prohibitive for this condition, unless possibly an exception might be made of the polyphase induction motor. For signals with a high ratio of gearing either a commutator or induction motor has suitable torque characteristics.

Having decided on the lowest voltage at the terminals of the motor at which it will be required to operate, the motor should be tested in the signal with the spectacle, roundels, blade, up and down rod, or other parts with which it is to be used. With the semaphore and connected mechanism in the stop and caution positions it should be ascertained if the application of the minimum allowable voltage decided upon will clear the signal with the voltage maintained constant.

Another test should be made by bringing the motor to a full stop at about every five degrees of the stroke by lowering the voltage. The voltage should be raised after each stop to determine the minimum voltage at which the motor will clear the signal at that position. This series of readings will show the voltage at which the motor will clear the signal from any position.

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An ordinance has been passed authorizing the city officials of Wilkes-Barre, Pa., to pay part of the cost of the right-of-way and construction of a steel reinforced concrete combined highway and street railway bridge over the tracks of the Pennsylvania Railroad, the Lehigh Valley and the Central of New Jersey. The bridge is to be built from South Washington street, between South Welles street, between South and Ross streets.

The Pennsylvania Lines, the Baltimore & Ohio and the New York Central Lines are planning the construction of new bridges over the Calumet river, at Chicago, Ill.

The Kansas City Terminal Ry. Co. will start work this summer on the construction of thirty-two viaducts and five subways in connection with its improvements at Kansas City.

# Block Signaling in the United States in 1910.

The accompanying table was compiled by the block-signal and train-control board, under the direction of the Interstate Commerce Commission, from reports made by railroad companies in response to the Commission's order of September 19, 1910. The total length of road in the United States operated under the block system on January 1, 1911, was 71,269.1 miles. Of this total, 17,711.5 miles were automatic, and 53,557.6 miles were manual. There was an increase of 3,473.8 miles in the length of road covered by the automatic block system, and an increase of 2,037.3 miles in the length of road covered by the manual block system, over the figures shown in the bulletin of January 1, 1910. The total increase in the miles of road operated under the block system during the year was 5,511.1.

Comparing the present report with the report for January 1, 1910, notable changes appear in the table shown herewith, the figures in each case representing miles of road.

The railroads given below had not previously reported the use of the block system:

Beaumont, Sour Lake & Western (St. Louis & San Francisco).
Central New England.
Chesapeake & Ohio Railway of Indiana.
Chicago, Rock Island & Gulf.
Evansville & Terre Haute.
Kentwood & Eastern.
New Orleans & North Eastern (Queen & Crescent).
New Orleans, Texas & Mexico (St. Louis & San Francisco).
Orange & Northwestern (St. Louis & San Francisco).
Quincy, Omaha & Kansas City and Iowa & St. Louis.
Toledo, Peoria & Western.
Toledo, St. Louis & Western.
Western Pacific.

And the following electric or "interurban" lines which were not included in preceding bulletins:

Auburn & Northern.
Illinois Traction.
San Francisco, Oakland & San Jose Consolidated.
Syracuse, Lake Shore & Northern.
Tidewater Power Co.
Washington Water Power Co.

The Atlanta & West Point, the Davenport, Rock Island & Pacific, and the Mississipppi Central, which have heretofore reported the use of the block system on their lines, do not appear in this bulletin, as reports from these companies indicate that the block system is not used.

The Duluth, South Shore & Atlantic and the Western Railway of Alabama appeared in former bulletins, but do not appear in the present compilation, as these companies have reported that the block system is not now used on their lines.

Railroad companies have reported the following proposed additions and changes which it is intended to carry out during 1911:

Atchison, Topeka & Santa Fe: 42.3 miles automatic; 146.7 miles manual.

Boston & Albany: 39 miles automatic to be rebuilt.

Boston & Maine: 423.6 miles.

Chicago & Alton: 41.6 miles automatic.

Chicago Great Western: 138 miles automatic to replace manual.

Chicago, Rock Island & Pacific: 3.5 miles automatic.

Cumberland Valley, 44 miles automatic.

Lehigh Valley: 20.1 miles automatic.

Long Island: 9.3 miles automatic.

Maine Central, 48.1 miles automatic.

New Orleans & Northeastern: 29.6 miles automatic.

New York, New Haven & Hartford: 137 miles automatic.

New York, Ontario & Western: 16.9 miles automatic.

Norfolk & Western, 103.6 miles automatic to replace manual.

St. Louis & San Francisco: 133.6 miles automatic.

Southern: 1,838.6 miles manual.

Southern Pacific: Pacific System: 99.3 miles automatic.

| Name of railroad. | Increase. | | Decrease, non-automatic. |
|---|---|---|---|
| | Automatic. | Non-automatic. | |
| | *Miles.* | *Miles.* | *Miles.* |
| Baltimore & Ohio | 28.8 | 43.2 | |
| Boston & Maine | 153.7 | | |
| Chesapeake & Ohio | 134.9 | | |
| Chicago Great Western | 117.8 | 1,039.9 | |
| Chicago, Rock Island & Pacific | 333.4 | | 154.1 |
| Cincinnati, Indianapolis & Western | | 57.2 | |
| Delaware, Lackawanna & Western | 52.5 | | |
| Great Northern | 60.6 | | |
| Hocking Valley | | 69.3 | |
| Illinois Central | 36.5 | | |
| Long Island | 21.2 | | |
| Louisville & Nashville | 11.0 | 279.6 | |
| Maine Central | 153.0 | | |
| Minneapolis, St. Paul & Sault Ste. Marie | | 265.5 | |
| Missouri Pacific: St. Louis, Iron Mountain & Southern | 29.5 | | |
| New York Central Lines: | | | |
| Cleveland, Cincinnati, Chicago & St. Louis | | 57.1 | |
| Peoria & Eastern | | 81.2 | |
| Northern Pacific | 179.0 | | 396.7 |
| Pennsylvania: | | | |
| Grand Rapids & Indiana | | 55.8 | |
| Pennsylvania Co. | 103.6 | 170.5 | |
| Philadelphia, Baltimore & Washington | | 47.8 | |
| Pittsburg, Cincinnati, Chicago & St. Louis | | 32.6 | |
| Vandalia | | 124.0 | |
| St. Louis & San Francisco | 428.8 | | 122.4 |
| Southern Pacific, Atlantic System: Galveston, Harrisburg & San Antonio | 63.8 | | |
| Southern Pacific, Pacific System | 279.9 | | |
| Union Pacific | 116.2 | | |
| Oregon Short Line | 203.0 | | |

**Block Signaling in the United States, 1910.**

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The Central Railroad of New Jersey is interested in the construction of two new bridges at Roselle, N. J.

The Central Carolina R. R. Co. will erect a bridge about 500 ft. long near Broadway, N. C.

# Alternating Current for Operating Signals

The first automatic signals on a steam road using alternating current for operating and lighting the signals, as well as supplying the track circuits, were installed on the Cumberland Valley Railroad between Lemoyne and Mechanicsburg, a distance of seven miles, in 1908, and have just recently been put in service.

Power for operating the system is supplied from a 2,200-volt, 25-cycle, single-phase, alternating current line carried on poles along the right-of-way, current being obtained from the power plant of the United Electric Company located at Lemoynt, Pa. Lightning arresters are placed at intervals of two miles and trouble from lightning has been confined practically to an occasional fuse blown out. The signals have three positions in the upper right hand quadrant, normally clear; they are lighted electrically. The small amount of energy used by the 2-candlepower electric lamps to light the signal does not justify putting them out in the daytime, and the use of electric lights not only avoids the expense of maintaining oil lights, but gives better service in that there is no smoking of lamps and lenses, and light failures are reduced to a minimum.

Transformers are used at each signal location with suitable taps to step the voltage down from 2,200 to 55 volts for operating the signal motor and lights, and to 5 volts for track circuits, controlled by suitable resistances. The motors are of the induction type and have no contacts or brushes and no friction surfaces aside from the two armature bearings. The relays are of Galvanometer type for track circuits with a Vane type for slow release control.

The polarized system of alternating current track circuits is used; this controls the third or clear position of the signals, without the use of line wires, so that the two main wires are the only line wires used in the automatic territory. Track circuits average one mile, the longest circuit being 7,000 feet.

On many steam roads having trolley lines in close proximity it is frequently found that the return current of the trolley line will follow the rails of the steam road and if the steam road is using a signal system of direct current track circuits, constant care must be used to prevent the stray trolley current from affecting the relays of the signal system and causing them to give a false indication. The use of alternating current for track circuits effectively prevents any trouble due to stray currents as the relays will not respond to any current except the alternating current of the particular cycle and phase for which it is adjusted.

No batteries are used on any part of the Cumberland Valley Automatic Signal System and the maintenance expense is limited chiefly to the proper lubrication of the signal mechanism, and the care of the rail bonds and insulated joints.

The operation of these signals has been so satisfactory that a contract was recently awarded for signaling forty-three additional miles of double track on the Cumberland Valley, divided into three sections; Mechanicsburg to Mile Post 27, Shippensburg to Chambersburg, and West of Chambersburg to Mason-Dixon, together with the single track between Lemoyne and Harrisburg, a distance of about one mile, where the Susquehanna River is crossed by a single track bridge; 25-cycle, single-phase, alternating current, at 3,300 volts, is to be used with such modifications and improvements in the signals and equipment as have been made since the original installations. An additional unique feature is carrying sufficient current in the signal mains to supply electric lights at all stations as well as to operate the signals. This will be the first instance of such use of signal circuits on a steam road. The current supply for this signal and lighting system from Harrisburg to Mile Post 27 will be furnished by the United Electric Company, Lemoyne, Pa. The sections East and West of Chambersburg will be supplied from the power plant owned by the company and located at Chambersburg, Pa.

The operation of automatic block signals of the three position upper quadrant type is as follows: If the line is clear ahead of a train, the signal blades will normally stand in a vertical position indicated by a white light at night, with a red marker light seven feet below it and two feet to the left of it, giving it a staggered effect, indicating that it is an automatic signal. If a train occupies the block immediately in advance of a signal the blade or arm will assume a horizontal or stop position, indicated by a red light at night; the following train will come to a full stop at the signal and then proceed carefully, expecting to find a train ahead. If a train approaching the signal finds the blade in the forty-five degree position, indicated by a green light at night, it shows that the block immediately in advance is clear, but that the second block ahead is occupied. Under this arrangement, a train approaching a signal showing a white light is assured of two clear blocks, or, in other words, the track is clear for two miles ahead. At an interlocking tower three blades are shown in a horizontal position, and at night three red lights in a vertical position, indicating stop and stay to an approaching train until they receive a clear signal to proceed. If given the top blade or white light at an interlocking tower, a train may proceed at full schedule speed; if given the middle blade, or white light, a train may proceed at limited speed and if given the lower blade, or white light, the train will proceed at low speed prepared to stop immediately.

## TRAIN DISPATCHING BY TELEPHONE.

The Chicago, Burlington & Quincy R. R. has a force of men installing ninety-six additional miles of telephone wire and instruments from Kansas City to St. Joseph, Mo., and from St. Joseph to Napier, Mo. This stretch of line, which is double tracked, is one of the most important on the Burlington system.

The Burlington now has the greater portion of its lines under telephone service control.

Recently the Missouri, Kansas & Texas finished building 355 miles of telephone lines in Texas, and the same road has a majority of its lines in other states controlled by telephone.

The Louisville & Nashville is another large system to adopt the telephone instead of the telegraph, and recently completed a private line from Louisville to New Orleans, which is one of the longest private telephone lines in existence.

It is reported that the New York, New Haven & Hartford is making improvements to the power house at Cos Cob, Conn. A contract for erecting the power house building has been let to F. T. Ley & Co., Springfield, Mass. The enlarged power house will furnish single-phase current for the operation of the electrified part of the New York division, including the section now operated between Stamford, Conn., and Woodlawn Junction, N. Y., and, in addition, for the Harlem River six-track branch and the New York, Westchester & Boston, a subsidiary now under construction. Three-phase current will be supplied to substations for street railway power and general lighting at Stamford, Conn., Greenwich, Port Chester, N. Y., and Mamaroneck. Full contracts for machinery and apparatus have not yet been awarded.

## The Maintenance of Way Department

### SQUARE OR BROKEN JOINTS ON TANGENTS.

A majority of the larger railways in the United States are using broken joints on their track, both for curves and tangents. Square joints on tangents are used by the Missouri Pacific; the Chicago, Milwaukee & St. Paul*; the Chicago & Northwestern; and the Chicago, St. Paul, Minneapolis & Omaha. We publish herewith letters from several chief engineers, stating the reasons for their standard.

Editor Railway Engineering:

In regard to square or broken joints on tangents, I beg to advise that on tangents our standard is the broken joint. As to the reason for using this broken joint, I would say that on all old roads well ballasted, and having heavy traffic, a broken joint is preferable to a square joint. Even joints are used on new lines not fully ballasted, on account of the banks settling. Under such conditions, and on light track where the joints settle, it is claimed that the track rides easier, there is less lateral motion and the track can be better mainained. With broken joints, the number of low places would increase and the weight of the train would be thrown laterally against these low joints, tending to throw the track out of line. On broken joints, the hammering effect which tends to cause low joints is better distributed over the track and there is less difficulty in keeping up the joint, also the train rides more smoothly. For this reason our road has decided to use broken joints and made it the standard.

L. C. Fritch, Chf. Engr.,
Chicago Great Western R. R.

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Editor Railway Engineering:

The Rock Island standard calls for broken joints on both curve and tangent, for the simple reason that in our judgment all arguments we have ever seen presented in favor of both types show a large balance in the favor of the broken joint.

J. B. Berry, Chf. Engr.,
Rock Island Lines.

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Editor Railway Engineering:

We use broken joints on all first-class track. The only place where we use square joints at present is on a new roadbed where we do not use ballast. We are using broken joints on new roadbed wherever we ballast before putting track in service, as in the case of our second track. The reason for not using the broken joints on the new unballasted roadbed is that it causes a very bad rolling effect owing to difficulty in keeping up joints, which is hard on rolling stock and disagreeable to passengers. In the case of the solid roadbed the object in using broken joints is that a smoother riding track can be maintained, doing away with the decided click or jar that there is in passing over two joints at the same time with the same axle. It also makes a stronger track, which was the reason that it was first, and on many roads is now, only used on curves, as the joint is the weakest point on the track, and by doing away with two joints opposite it tends to stiffen the track.

C. A. Morse, Chf. Engr.,
Atchison, Topeka & Santa Fe.

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Editor Railway Engineering:

It is the practice of this company to lay all rail with staggered joints; that is, the joint on one rail coming opposite the center of the other. We believe this to be the proper method, as matched joints produce a very uneven and objectionable motion when they begin to get battered or low. The above remarks refer to all track that can be reasonably expected to be maintained in a fairly good condition. On obscure branches where traffic is very light and maintenance expenditures low, it is probably advisable to use matched joint. While the comfort of a passenger is less, the liability of derailment if the track gets bad is also less.

C. S. Millard, Engr. Trk. & Rdy.,
C., C., C. & St. L.

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Editor Railway Engineering:

All of our track is laid with broken joints and has been for so long that we have pretty nearly forgotten the reasons, which, however, are abundant.

Sam'l Rockwell, Chf. Engr.,
L. S. & M. S.

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Editor Railway Engineering:

It is the practice of the Baltimore & Ohio to use exclusively broken joints on tangent and curved track, for we have found that broken joints make easier riding track, less liable to get out of line and less expensive to maintain. With the use of broken joints, the hammering effect which causes low joints to batter is better distributed over the track, and there is less difficulty experienced in keeping up the joints. We have laid, at different times, sections of track with even joints on tangent, and find that the even joint causes rail to surface bend more quickly than where laid with broken joint. It is the consensus of opinion of our engineers that broken joints make a better riding track, and require less maintenance work to hold surface and line.

E. Stimson, Engr. M. W.,
Baltimore & Ohio R. R.

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Editor Railway Engineering:

Our track is now mostly laid with square joints to conform to orders of our late president. Our present president has given orders to lay all joints broken. My personal opinion is that square joints are the best on mud ballast where the track is likely to be pretty rough and that broken joints are preferable where good ballast is used and the track kept in good surface.

J. P. Snow, Chf. Engr.,
Boston & Maine.

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Editor Railway Engineering:

We use broken joints on all our track; the reason for same is that there is less difficulty in keeping track to surface. The blow of a falling body is proportioned to the height. Our rolling stock is carried on center bearings; if one side of the track only is down, the body only falls half the distance it would fall if both sides were down; therefore the blow delivered is only one-half as great.

J. G. Sullivan, Asst. Chf. Engr.,
Canadian Pacific Ry.

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Editor Railway Engineering:

On all track laying recently we have used broken joints, both on tangents and curves, also on first-class ballasted track and second-class branch line track with earth ballast. I feel that our experience has demonstrated that upon first-class ballasted track, both on curves and tangents, better track as to detail of alignment, as well as uniformity of surface, could be main-

*Contrary statements on the part of an employe of the chief engineer's office notwithstanding.

tained with rail so laid than with rail laid square joints. I further feel that on such track the passing of wheels over the joint is less pronounced and causes less shock to equipment than with square joints. On cheaply maintained branch lines I do not feel that the same advantages are in all cases secured. In fact, until within recent years I have felt that square joints on tangents on branch lines using earth ballast, where cheap maintenance was a requirement, gave quite as good results as broken joints. Upon such track, the time of the men on maintenance was directed principally to maintaining the joints in proper line and surface, and it has at times seemed that this could be done quite as expeditiously and economically with the joints supported by one or two ties, which could be raised or lined as the circumstances might require, as to do this work by raising or lining twice the number of ties. Further, it was thought that in the event of the track becoming slightly out of surface by reason of the joints settling, the motion communicated to the train was less objectionable than that which would be communicated in the event of the same conditions at the joints using broken joints. At this time I am not in favor of square joints under light traffic, as I believe, even with light traffic and cheap maintenance, broken joints on tangents give more satisfactory results both as to maintenance and operation.

Wm. Ashton, Chf. Engr.,
Southern Pacific.

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Editor Railway Engineering:

On this road we lay broken joints altogether. In previous years small sections of square joints were laid, which we have not yet taken out. This, however, is being done as rapidly as possible. We find that with the ballast used we can better maintain a higher grade of maintenance by the use of broken joints. It is claimed at points where the grade is heavily descending that square joints are more desirable, but I have never been able to understand this claim. It is my opinion that it is better to provide against rails creeping by some other method than the use of square joints, in order to carry the ties uniformly with the creeping of the rail. It is also claimed that in poor ballast the square joint is better on account of the uniform vertical movement, both joints going down at the same time. This reasoning seems to have some merit.

Edw. Gagel, Chf. Engr.,
New York, New Haven & Hartford R. R.

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## RAILWAY CONSTRUCTION.

It is reported that the contract for building under the name of the St. Paul & Kansas City Short Line, from Carlisle, Iowa, south to Allerton, has been let to the McArthur Brothers Company, Chicago.

The M. St. P. & S. Ste. M. has incorporated a subsidiary company in Illinois to be known as the Central Terminal Railway Co., for the purpose of arranging a Chicago terminal. Freight yards, freight offices and freight sheds are to be built. Condemnation proceedings have been instituted to obtain property which the company has been unable to buy in negotiations commenced over one year ago. Two years will be required to develop the property.

The Tennessee & North Carolina which operates a 21-mile line from Newport Junction, Tenn., south to Crestmont, N. C., is planning to build an extension from Waterville, southeast to Canton, 38.5 miles.

Plans have been made by the Akron, Canton & Youngstown to build from Akron, Ohio, southeast to Mogadore over part of the route of the old projected line from Akron, via Canton, to Youngstown. H. B. Stewart, president, Canton.

The Bay Shore Rapid Transit Co., La Porte, Texas, has awarded the contract to the W. E. Ule Construction Co. for building its projected line between Houston, La Porte and Sylvan Beach, a total distance of about 35 miles.

The Raleigh & Southport, it is said, will soon start work on a branch from Lillington, N. C., west to Sanford, about 25 miles. The company will carry out the work with its own men.

The contract for completing the extension of the Philadelphia Western Ry. from Stafford to Norristown and North Wales, to connect with the lines of the Lehigh Valley Transit Co. at North Wales, has been awarded to Stone & Webster, 147 Milk street, Boston, Mass. The estimated cost is $2,000,000.

According to reports, surveys are now being made by the Chicago, Rock Island & Pacific, for a branch from Walco, Ark., one mile south of Malvern, to which place a spur has already been built south through a lumber belt, to Caruder. This line is to be about 50 miles long, and it is understood, will eventually be extended south to Eldorado or to some point on the Crossett line.

The Southern Pacific has given a grading contract to the Utah Construction Co. for double-tracking work from Lucin, Utah, west to Montello, Nev., 18 miles.

According to reports, the Hudson Bay Railway has asked for bids for building a section of 180 miles of the line projected from La Pas, Keewatin, north to Hudson Bay. It is expected that contracts for other sections will be let in July. Surveys for the first 250 miles have been made. It is expected that the work will be started this summer and finished during 1914.

It is said that an extension is to be built by the Idaho Northern Railway during the next two years, from the present terminus at Emmett, Idaho, through Long valley to the Payette lakes, about 100 miles. Bids have already been asked for work on a section of about 28 miles from Emmett, northwest.

According to reports, a large force of men are at work on the Minneapolis, St. Paul & Sault Ste. Marie line from Frederick, Wis., north to Duluth, Minn. Foley, Welch & Stewart, St. Paul, is the contractor. It is expected to have the line ready for operation this coming fall. Track is now being laid on the bridge over the St. Croix river on the cut-off from New Richmond, Wis., west to Withrow, Minn. The St. Croix river bridge is part of the plan of straightening the Chicago division or old Wisconsin Central line, on which much work was done last year. The cut-off will shorten the line into Minneapolis by 12 miles, and passing over the St. Croix river at a height of 190-ft. will avoid the high grades over which the Wisconsin Central operated.

A grading contract has been let by the Kansas City, Mexico & Orient to Roach & Stansell, Memphis, Tenn., for work on the section from Mertzon, Tex., southwest via Fort Stockton, to Alpine, 196 miles.

The Canadian Northern has let contracts to complete the 250-mile Toronto-Ottawa line. J. P. Mullarkey, Montreal, Que., has a contract for the section between Mile 164 and Mile 180, and between Mile 200 and Mile 250. He will also do the track laying and ballasting on the 20-mile section between Mile 180 and Mile 200, for which contract for the grading and timber work has been let to Ewan Mackenzie, Toronto, Ont. A contract has also been let to A. Sinclair, Toronto, to complete the section between Toronto and Belleville.

It is said that the Towson & Cockeysville. has let contracts to the James H. Harlow Co., to build from Towson, Md., north via Lutherville and Texas to Cockeysville, 7.5 miles. Maximum grades will be 3 per cent., and maximum curvature 6 deg. There will be an 80-ft. steel bridge and a concrete undergrade crossing. J. A. Shriver, president, Bel Air.

The Chicago & Northwestern is constructing a belt line around Milwaukee which, it is reported, will be ready for use Sept. 1, 1911. The Northwestern is also constructing a new terminal freight station, including a large roundhouse, at Butler, near Milwaukee.

The Cincinnati, Madison & Western Traction Co., Hanover, Ind., will receive bids until May 30 for constructing a railway to connect Hanover, Madison, Scottsburg and Lexington. The line will be about 40 miles long.

# Personals

C. H. Jones, assistant resident engineer of the Western Maryland, has been appointed chief engineer of the New York & Pennsylvania, with office at Canisteo, N. Y.

J. H. Conlen, division roadmaster of the Great Northern at Whitefish, Mont., has been appointed roadmaster at Spokane, Wash., succeeding P. C. Connelly, transferred to the operating department.

John Garrity, division roadmaster of the Great Northern, at Marcus, Wash., has been transferred to Whitefish, Mont., succeeding J. H. Conlen, transferred. F. W. Stiles, assistant roadmaster at Everett, Wash., succeeds Mr. Garrity.

The office of supervisor of timber preservation on the Rock Island Lines has been abolished, and C. F. Ford has been appointed supervisor of the tie and timber department, with office at Chicago. Mr. Ford will have charge of timber preservation, succeeding Dr. Hermann Von Schrenk, assigned to special work.

F. L. Stone, engineer of track elevation of the Chicago, Burlington & Quincy at Chicago, has resigned to engage in other business.

J. H. Cummings, roadmaster of Divisions 4 and 5 of the Buffalo, Rochester & Pittsburg, at Punxsutawney, Pa., has been appointed roadmaster of Division 4. George T. Tweed, extra gang foreman, has been promoted roadmaster of Division 5. Both will have offices at Punxsutawney.

E. G. Stradling has been appointed signal engineer of the Chicago, Indianapolis & Louisville, with office at Lafayette, Ind.

Walter Wells, master carpenter of the Chicago division of the Chicago, Burlington & Quincy, has been transferred to the track elevation department and his former title has been abolished, the duties of that office being assumed by the master carpenter of the Aurora division.

Charles Scott, general foreman of the Buffalo, Rochester & Pittsburg, has been appointed supervisor of bridges and buildings for Divisions 1 and 2, with office at East Salamanca, N. Y., succeeding J. C. Rouse, master carpenter, retired under the pension rules. E. W. Fair, master carpenter, at Du Bois, Pa., has been appointed supervisor of bridges and buildings for Divisions 3, 4 and 5 of the Erie division, with office at Dubois, and the title of master carpenter has been abolished.

M. N. Wells, division engineer of the Atchison, Topeka & Santa Fe at Chanute, Kan., has been appointed an assistant engineer, with office at Chanute.

M. A. McNeill, acting roadmaster of the Rio Grande division, Atchison, Topeka & Santa Fe, has been appointed roadmaster of the Pecos division with office at Pecos, Tex.

J. H. Stinson has been appointed roadmaster of the Southern Kansas Railway Company of Texas, office at Canadian, Texas, succeeding F. B. Hart.

F. B. Hart has been appointed roadmaster of the Plains division, Pecos & Northern Texas, with headquarters at Amarillo, Tex.

Henry Jordan has been appointed roadmaster of the Detroit, Bay City & Western with office at Bay City, Mich., succceeding M. J. Sullivan, resigned.

# With The Manufacturers

## New Literature

Fairbanks Morse & Co. have recently published catalog No. 6, describing their Eclipse Pumper. Illustrations show the varied uses to which the engine may be put, in addition to running a pump.

* * *

The Dake Engine Company, of Grand Haven, Michigan, has issued a booklet describing and illustrating Dake engines, The text is neat and very systematically arranged. The cover design is unique and gives the booklet an unusually attractive appearance.

* * *

"Railway Settees and Public Seating" is the title of catalogue No. 32, issued by the American Seating Co., 218 S. Wabash Ave., Chicago. A full-page illustration near the front shows the five large plants operated by this company. The construction of the seats and settees is described. A great number of illustrations, with accompanying descriptions, show the large number and varied patterns manufactured.

* * *

One of the most artistic and well designed catalogues we have seen is that issued by the Sellers Manufacturing Company, McCormick Building, Chicago, describing their different types of tie plates. The illustrations and type throughout are distinctive and of high class.

* * *

Cooks Standard Tool Co., Kalamazoo, Mich., has issued a small booklet describing and illustrating their line of products, which includes Climax track drills and Magic chucks, bits and grinders. Repair parts are illustrated, catalogued and priced, in addition to the complete outfits.

Catalogue No. 114 has been issued by the C. W. Hunt Company, 45 Broadway, New York. In it are illustrated and described their line of grab buckets, coal buckets, valves, chutes, screens, etc. Capacities, sizes and prices are tabulated in handy form so that the purchaser may easily compare the different sizes and prices.

* * *

Harry Bros. Co., of Louisiana, offices at New Orleans, has issued general catalogue No. 6, entitled "Harry's." The history and objects of the company are set forth in the foreword The tables given show that this company manufacture corrugated iron tanks in a great assortment of designs, sizes and prices. The text is accompanied by a large number of illustrations.

## New Books

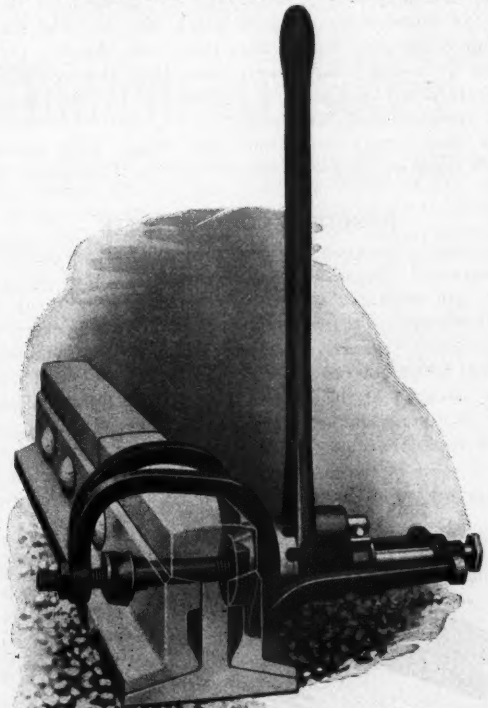
RAILWAY STATION SERVICE. By B. C. Burt (of the C. & N. W. Ry.); 292 pages, cloth; 5x7¼ inches. Published by John Wiley & Sons, New York. Price $2.00.

No one will deny that the very excellent standard of station service maintained by the Chicago & Northwestern Ry. qualifies, at least, some of its officers and employes to write on the subject. We believe that Mr. Burt is one of those to be mentioned in this category. His book is not designed as a manual explaining merely in a matter-of-fact way, either in complete detail or in outline, what things must be done at a railway station and how to do them. While stating with some fullness the leading features of railway station service as matters of prescribed routine, attempts have been made to give also some insight into the general condition, spirit and principles of such service. It is a fact, familiar to every agent of experience, that the station man is depended upon by his superior officers not merely for a

proper knowledge and application of his company's rules, but, in addition, for information and for well-advised opinions on a multitude of matters not covered by those rules; and the agent is well aware of the fact that his services are of value to his company very much in proportion as he is able to meet this additional demand. Furthermore, in recent years, legislation regarding railway matters has been such that the agent has been rendered in a measure independently responsible, so that it behooves him to become informed as to conditions under which he is placed, not by his company in the first instance, but by federal and state laws. And, again, the public whom the railways serves looks to the agent as its chief informant and adviser in matters relating to the business of shipping and of traveling. In general, the tendency of circumstances—a tendency that is undoubtedly increasing in strength—is toward the necessity of the agent's being not merely a hired servant of his company, but an all-round, intelligent, capable individual person. It is in accordance with, if not in consequence of, this tendency that schools have in recent years been established and are being established to fit men for the really intelligent understanding and performance of duties connected with railway service in general. The present work aims to contribute something towards meeting the demand involved in this tendency, so far as station service is concerned. The matter of the book has been derived mostly through an experience of a dozen or more years on two leading lines of the West, no written work covering precisely the field of the book having fallen into the author's hands.

## NATIONAL RATCHET TRACK WRENCH.

The accompanying illustration shows a track wrench, of a new type, in position and ready to tighten up the nut on a track bolt. It will be seen that the head of the bolt is held close to the rail by the clamp, and the bolt cannot turn, as often happens when a nut is being tightened up with an ordinary track wrench. The socket which engages and turns the nut has a snug bearing on every side, and thus cannot slip over and round off the edge of the nut. The clamping device prevents the socket from slipping out and off the nut. These features prevent the spoiling of nuts, and the gradual enlarging and rounding effect on the track wrench which in time becomes useless.



National Ratchet Track Wrench.

The clamping device does not touch or catch under the ball of the rail, and the tool can be removed instantly when a train approaches. The sockets used are interchangeable and made for all sizes of nuts, either square or hexagon. The ratchet and socket are made in one piece, giving maximum strength. Means are provided for accurately taking up all wear, thus insuring that the nut always fits snugly into the socket.

With this wrench the claim is made that a man can accomplish three or four times as much work as with an ordinary wrench. It is equally adaptable to putting on or removing nuts on new construction or repairs. Any standard rail section or rail joint is easily fitted by the adjustable device, and for special joints a special design can be easily made from a sketch.

The device is built light, as there is no great strain and no need for great strength in any of the parts except the socket. The National Ratchet Track Wrench is handled by the National Surface Guard Co., The Rookery, Chicago.

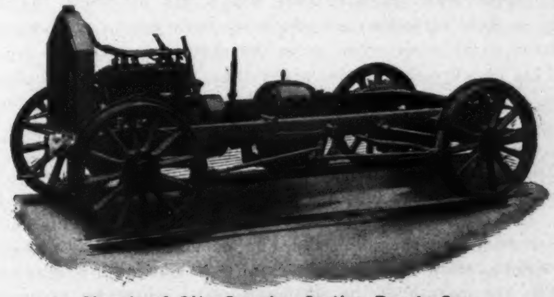
## AN INNOVATION IN SECTION REPAIR CARS.

We illustrate herewith the Otto gasoline section repair car, which was especially designed for use by the Chicago & Rock Island Railroad, and which has a number of interesting features. Briefly, the purpose of the car is first to afford means of conveying men and tools to the point where repairs or new work are necessary, with the greatest convenience and speed; and second to supply the necessary power to operate automatic tools.

Motive power for the car is supplied by a 30-35 horsepower four-cylinder, four-cycle gasoline engine. Electric power for operating the electric tools carried is supplied by a 10-horsepower generator, operated by the same engine which propels the car.

If necessary, 8 to 10 men can be conveniently carried and as many tools as can be placed upon it. The tools delivered with this particular car include two electric spike screwing machines, three electric drills, electric saw for rails, and portable emery wheels. Where occasion requires, or where it is desirable for any reason, an additional car or tender can be readily coupled to this car for carrying spikes, extra cable, or anything in the way of material, additional tools, or men, as desired.

The car is operated practically on the same manner as an automobile. When the driver throws the clutch into



Chassis of Otto Gasoline Section Repair Car.

engagement with the engine to run the car, the generator is disengaged, and similarly when the car reaches the point of operation the engine is disengaged from the transmission and engaged to the generator.

To eliminate the necessity of constantly moving the car along the track from one small operation to another, a quantity of cable is caried which can be laid along the track and furnish current for the motor-driven tools for probably a quarter mile each way from the car. About

twenty feet apart all along this cable are plug-in switches, and each electric portable tool is equipped with a special stage plug. The tool is simply carried along to any point needed for the length of this cable and plugged in at the most convenient switch.

The gasoline engine is water cooled by an extremely large radiator of honey comb type, in order to insure satisfaction under all kinds of weather conditions, and when the engine is constantly running at considerable speed in operating the generator.

The frame of this special car varies from that in the regu-

Completed Otto Section Repair Car.

lar Otto car only in the fact that it is considerably heavier where required, as in the axles and in the support for the generator, etc. The transmission affords three speeds, forward and reverse. Heavy artillery wheels with steel tires are used. The front wheels operate on Hyatt roller bearings, and are packed in grease. Rear wheels are keyed to the shaft and lubricated with grease cups. The brakes operate by a lever bearing on both front and rear wheels, one expanding against the other. The four springs are full elliptic. The wheel base is approximately 100 ins., and the weight is about 3,000 lbs. The tank carried will store about 15 gallons, and would probably require refilling for every 10-hour day's running, but an extra five or ten gallons will probably always be carried.

This car is a product of the Otto Gas Engine Works, Ellsworth Bldg., Chicago.

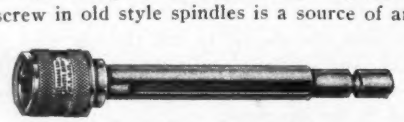
## MAGIC TRACK DRILL CHUCKS.

The "Magic" track drill chuck embodies unusual features. It will hold either an ordinary twist bit with round shank, or the Magic high speed flat bit, which has no shank. The bits are held between jaws which are tightened by the sleeve instead of by a set screw as in the ordinary spindle.

This chuck is but little larger than the ordinary spindle, and does not add to the weight of the machine. The sleeve holds the bit perfectly, and yet the bit can be released by the slightest turn.

The jaws are an integral part of the chuck and can not lose out. The flat bits are centered by the small-grooved jaw and the twist bits by the large-grooved one. This and other features are patented. The flat bits may be moved forward as they wear until practically the entire bit is used.

The elimination of the set screw is an important feature. The set screw in old style spindles is a source of annoyance,

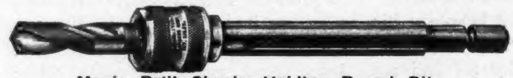


Magic Drill Chuck.

Magic Drill Chuck, Holding Flat Bit.

especially with the ordinary twist bit with round shank. Frequently the set screw will draw into and lock the round shank and much time may be wasted in releasing it from the spindle. Even after the set screw is loosened, the burr it has raised upon the shank of the bit often makes it very difficult to remove the bit from the socket.

As can be seen from the accompanying illustration Magic



Magic Drill Chuck, Holding Round Bit.

high speed flat bits used in our Magic chuck require no shanks. The nature of high speed steel is such that a shank weakens the bit. In the Magic chuck the bit is materially strengthened by being held rigidly between the jaws.

The Magic flat bit is made of a very fine quality of high speed steel. It is claimed that one of these bits will drill forty or fifty times as many holes with one sharpening as a twist bit of carbon steel. The flat bit cuts a smooth, round hole and does not draw into the rail when pricking through as a corkscrew-shaped bit does. The loss of time occasioned

Magic Drill Chuck Showing Parts.

by a gang of men working to extricate a bit thus caught, the breakage and strain of the drilling machine, and the resulting breaking of bits are most important items of expense.

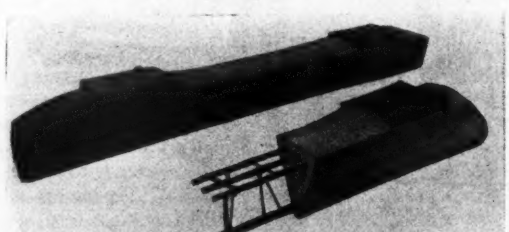
Four special points of advantage are claimed for the flat bit: (1) There is no shank to break off. (2) The flat bits without shanks are cheaper than those with shanks. (3) The bit can be moved forward as it wears thus getting the maximum use. (4) The jaws strengthen the bit and the bit is easily released from the chuck.

The Magic track drill chuck and Magic high speed flat bits are made by Cook's Standard Tool Co., Kalamazoo, Mich.

## PERCIVAL CONCRETE TIE.

This tie is designed of reinforced concrete, with wooden rail cushions. Some of the advantages claimed by its inventor are strength, durability, comparative lightness, positive insulation of track circuits, elimination of center binding, economy, proved value under test, and adaptability to different widths of rail base.

The strength of the tie has been proven by actual use in track. A derailment occurred in one place where they were installed and the gage of the track was not disturbed. The ends of some of the ties were somewhat broken up, but none bad enough to necessitate removal. The weight of ties of



Construction of Percival Concrete Tie.

Place Where Wreck Occurred on Percival Concrete Ties. Track Left Safe and in Perfect Guage.

this design would be from 380 to 450 lbs. for steam railways. This compares very favorably with other ties of concrete construction. Center binding is eliminated by the tie being designed in a "V" shape in the center. Thus the greatest bearing surface is under and near the rail base. The rail sets on a wooden block cushion (for resiliency) which is partly unbedded in the concrete. The rails are fastened by screw spikes, which pass through holes in the wooden blocks, and screw into babbitt sockets imbedded in the concrete. Test installations of these ties have shown excellent durability with low maintenance charges.

These ties are patented and manufactured by H. E. Percival, 1311 Fannin street, Houston, Tex.

## Industrial Notes

Wm. C. Wilson, formerly connected with Bingham & Taylor, Buffalo, N. Y., has been appointed to the sales-staff of the recently organized Transportation Utilities Company, direct representatives of the Acme and General Railway Supply Companies of Chicago, with headquarters at 30 Church Street, New York City.

The Hatfield Rail Joint Manufacturing Co. has been organized to manufacture rail joints. Mr. J. F. Scott, 11 Broadway, New York, is secretary and treasury of the company.

Clarence A. Bartlett has gone to the Garry Iron & Steel Company, Niles, Ohio, as sales agent, with office in Philadelphia, Pa.

Mr. Alva A. Griner, western manager of the Dahlstrom Metallic Door Co., Jamestown, N. Y., has been transferred to the east and placed in charge of the company's New York office. Mr. A. T. Hansen succeeds Mr. Greiner in Chicago.

The Chicago-Cleveland Car Roofing Company, Chicago, has moved its general offices from the Old Colony building to the Peoples Gas building.

The Willard Storage Battery Company, Cleveland, Ohio, has moved its Detroit, Mich., office from 227 Jefferson avenue to larger quarters at 1191 Woodward avenue. The office will be in charge of Max G. Hillman.

Dilworth-Porter & Co., Ltd., has awarded the contract for a new 18-inch mill for rolling tie plates, to be added to its Southside, Pittsburg, plant, to the United Engineering & Foundry Co., Pittsburg.

H. C. Ware has been made superintendent of construction of the western district of the Federal Signal Company, Albany, N. Y., with office in Chicago. J. J. Hubbard has been made superintendent of construction of the eastern district of this company, with office in Albany.

The Adams & Westlake Co. is said to have purchased a site for a plant, which they intend building, at Philadelphia.

The Sprague Electric Company, New York, has been merged with the General Electric Company, Schenectady, N. Y. The manufacture and sale of the lines of apparatus and supplies heretofore handled by the Sprague Electric Company will be continued by the Sprague Electric Works of the General Electric Company under the same organization, with D. C. Durland in charge as general manager. All correspondence should be sent to the Sprague Electric Works at the same New York address as in the past.

Henry B. Oately, engineer in charge of superheater design for the American Locomotive Co., has resigned to become mechanical engineer of the Locomotive Superheater Co., 30 Church street, New York.

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has recently received an order from the Toledo Railway & Light Company, for 100 type 310 C. box-frame, interpole, street railway motors.

At a meeting of the board of directors of the Penn Steel Castings & Machine Co., Chester, Pa., held on May 12, Mr. Walter S. Bickley was unanimously elected to the presidency of the company to succeed the late Mortimer H. Bickley.

Ambrose L. O'Shea has been made a director of the Gold Car Heating & Lighting Company, New York, succeeding W. W. Butler.

The T. W. Snow Construction Co., Ellsworth building, Chicago, has been incorporated to do a general fuel, contracting and construction business. The incorporators are: George T. Horton, August Ziesing and Ward W. Willits. Capital $150,000.

The Isthmian Canal Commission will receive bids until June 22 on miscellaneous supplies, including cargo-handling and locomotive cranes, electric cable and cable terminals. Circular No. 634.

The American Locomotive Co. has sent Mr. W. T. Rupert to Japan to superintend the setting up of several locomotives recently shipped to that country.

The Nova Scotia Car Works, Halifax, N. S., has been organized to take over the business of the Silliker Car Company, which is now out of existence. Sufficient new capital has been added to the business to make extensions to the plant and provide adequate working capital. The capacity of the plant, when extensions are completed, will be 20 cars per day.

The Philadelphia Locomotive Co., which it is said, is a reorganization of the Baldwin Locomotive Works, has increased its proposed capital from $40,000,000 to $50,000,000. The stock will be equally divided between common and preferred.

The Greenlee Brothers Company has removed its general sales offices from Chicago to Rockford, Ill., where the factory and accounting departments are located. The Chicago office is in charge of James A. Lounsburg, the vice-president.

J. J. Ross has been made manager of the western railway department of the U. S. Metal & Manufacturing Company, New York, with office in Chicago. Mr. Ross was formerly connected with the Featherstone Foundry & Machine Company, Chicago and also with J. V. Dowling & Company.

# Recent Engineering and Maintenance of Way Patents

### RAIL TIE.

992,789—Thomas F. May, Brandon, Manitoba, Canada.

This rail tie is composed of an upturned channel provided with wooden blocks to support the rail. The wooden blocks are held in place by an iron partition bolted in the channel. The rail is held by hook bolts which bolt through the partitions. Rail braces are fastened to the end of the channel, and bear against the outside of the rail.

### RAIL JOINT.

992,805—Frank S. Roberts, Mosier, Ore.

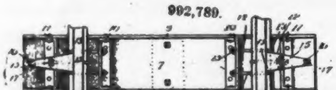
The rail joint shown is a combination of a rail and splice bar fitting against one side of the rail and connected thereto for longitudinally sliding movement, the splice bar being movable to project beyond one end of the rail to fit against the adjacent side of the companion rail and span the joint.

### RAIL GUARD.

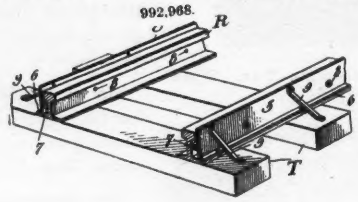
992,968—John J. Lynch, Anaconda, Mont.

A guard plate arranged adjacent to the rail having a flange formed on its lower longitudinal edge and disposed upon the base flange of the rail, the guard plate extending above the tread of the rail. Spikes extend through the flange on the lower edge of the

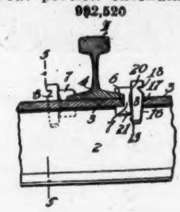
992,789.



992,968.



992,520



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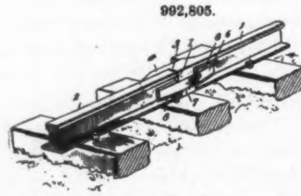
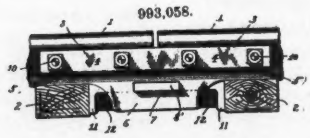


993,058.



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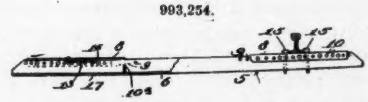


guard plate to secure the plate and the rail on the ties. A spacing bar is longitudinally disposed between the guard-plate and the web of the rail to space the inner face of the plate from the side of the rail head and bolts extend through the guard plate, the spacing bar, and the rail web, to rigidly secure them together.

### RAIL JOINT.

993,058—Robert T. Gunn, Lexington, Ky.

A rail joint comprising two rail ends, fish-plates having upper and lower flanges normally in contact with the rail ends, fastening means passing through the said fish-plates and webs of the rail ends, a downwardly extending section on each of the lower flanges passing below the rail bases and between the adjacent supporting ties for the rails and provided with an opening or slot. A key supported in the openings or slots and bears against the underside of the rail ends.

### RAILWAY TIE AND FASTENING.

993,254—James L. Kimball, Virginia, Minn.

A railroad tie having an open top with openings in the sides near the upper edges and rail seats having closed tops and side flanges formed with openings therein, the openings in the sides of the tie and the flanges of the seats being different distances apart so that a part of the openings in the two devices will be in registration for the reception of fastening devices and the remaining openings unoccupied. Fastening devices for rails co-operate with the tops of the seats.

### RAILWAY RAIL.

992,162—Walter L. Caven, Cincinnati, Ohio.

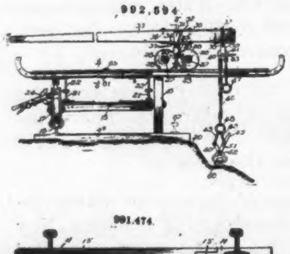
A railway rail comprising a tread, a web and a base distorted downwards between the ties, to increase the depth of the rail and thus stiffen it.

### RAIL- AND TIE-CLAMP.

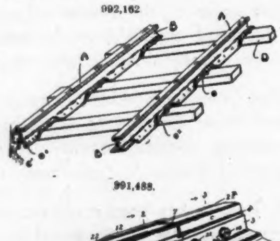
992,520—Daniel L. Rice, Canton, Ohio.

A rail having a base flange, and a plate supporting the base flange provided with apertures having their inner ends registering

992,594



992,162



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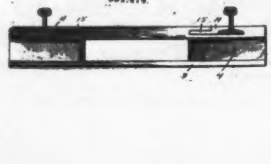

991,488.

with the edges of the flange; a clamp in each aperture having a jaw on each end normally clamps the flange and the plate with the inner side of its shank abutting against the edge of the rail and corresponding end of the aperture and the outer side of the shank being vertically concave between its end portions forming the heels of the jaws, has a wedge-key in the aperture outside the shank, one edge abutting against the end portions of the clamp and the other edge abutting against the outer end of the aperture.

### RAIL HANDLING APPARATUS.

992,594—John Reineher, Savannah, Ill.

A rail handling apparatus, mounted on a truck, comprising a lever, a rail grappling device, a flexible member to which the rail grappling device is connected, and means on the lever for securing the flexible member thereto, at different points along the length of the flexible member.

### RAIL TIE.

991,474—James E. Bliss, Faust, N. Y.

A railroad tie comprising an eye beam having an upper flange formed with rail seats, the opposing side wall of each seat being undercut, and the edges above the undercut portion extending in parallel relation and directly transverse the length of the tie, a wedge block having a section to engage the rectangular undercut portion and is formed with an inclined edge to engage the inclined wall of the undercut portion, and a relatively offset portion overlies and bears upon the remaining half of the base flange of the rail, the wedge block having a length exceeding the transverse dimension of the tie and being formed in that portion adapted to project beyond the tie when the block is in place with an opening. A bolt co-operates with the opening to prevent displacement of the wedge block.

### INSULATED RAIL JOINT.

991,488—William L. De Remer, Chicago, Ill.

A continuous angle bar and base plate in which one angle bar carries a plate portion extending nearly the full width of the rail base. The opposite angle bar has a shorter base portion. Insulating fiber is placed between the bar with the shorter base portion and the rail, and also around the bolts which hold the joint together.

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The Pecos Valley Southern is considering the building of an extension of 60 miles.

The Gulf, Colorado & Santa Fe, according to reports, has under consideration the question of building a branch from Carthage, Texas, northwest to Shreveport, La., about 50 miles.

The Raleigh, Charlotte & Southern was incorporated in North Carolina to built from Charlotte, N. C., northeast to Raleigh, about 140 miles, with a branch from Pittsboro northwest to Greensboro, 55 miles. Part of the construction work will be difficult. There will be six steel bridges. It has not yet been decided when contracts for the work will be let, but the prospects of building the line are good.

The Phoenix Ry. Co., Phoenix, Ariz., contemplates extending its system to Scottsdale and Ingleside. Samuel H. Mitchell, 1404 East Washington street, Phoenix, is general manager of the company.

The Louisville & Nashville is said to have given a contract to Buffat & Nipper, contractors, Knoxville, Tenn., for building an extension of the Lexington & Eastern from Whitesburg, Ky., to Dryfolk, six miles. The work will be difficult, being mostly through rock.